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Notes on Carex—VII

KENNETH K. MACKENZIE

CAREX UMBELLATA AND ITS ALLIES

A study of a number of recent collections, chiefly from the western part of the United States, has brought about the conclusion that in addition to *Carex umbellata* Schk. and *Carex deflexa* Hornem. and their allies, there are a considerable number of additional species belonging to the group Montanae, characterized by the development of pistillate spikes on subradical peduncles or on very short culms.

A natural division of these species can be made from certain characters taken from the perigynia. While all of the Montanae have the perigynia strongly 2-ribbed or 2-keeled, certain species of the group now under consideration found in California also have the outer face finely many-nerved. In all other members of the group the perigynia are nerveless or at most have on one face a few partly developed nerves on the lower half of the body.

Next to be separated are two closely related species of the southeastern United States (*Carex nigro-marginata* and *Carex floridana*). These are to be distinguished by the fact that while the spikes are on very short culms and may appear basal they are not on basal peduncles. Each culm really bears one to several pistillate spikes sessile at the base of the staminate spike; and elongated radical peduncles bearing only pistillate spikes are not normally developed, as in the remaining species.

After making this division probably the most satisfactory and

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natural method of telling *C. deflexa* and its allies from *C. umbellata* and its allies is that there are always pistillate spikes at the base of the staminate in the former, and the lowermost of these has a leaflet-like bract exceeding the inflorescence. This bract is rarely auriculate, and if colored at all at base is purplish-brown tinged. In the other group all the pistillate spikes are frequently subradical, but when there is a pistillate spike at the base of the staminate its bract is squamiform and shorter than the inflorescence, or else, if rarely longer, it is auriculate and strongly reddish-tinged at base.

Carex deflexa has a close ally in *C. Rossii*, the two species having been often confused. However, in *C. deflexa* itself the rootstock is very slender, horizontally creeping and short-stoloniferous; the perigynium is very small (about 2.5 mm. long) and strongly exceeds the scales; and the beak is short and but inconspicuously bidentate. In *C. Rossii*, as stated by Dr. Holm (Am. Journ. Sci. IV. **16**: 37. 1903), the rootstock is "much more robust, relatively shorter and ascending, not horizontal and not stoloniferous in the stricter sense of the word." This last species, too, has larger, longer-beaked and conspicuously bidentate perigynia, with relatively longer scales.

Carex brevipes W. Boott, a little-known species of the far western mountains, seems to be valid. It has the habit of growth of *C. Rossii*, but the short-beaked, narrow perigynia are about as small as those of genuine *C. deflexa*.

A very interesting collection made by Mr. W. W. Eggleston in the northern part of New Mexico in 1911, contains two new species belonging to the group of species now under discussion. One of these is related to *Carex deflexa* and its allies. It differs, however, in having few-flowered pistillate spikes even on fully developed plants. The beak of the perigynium is obliquely cut at apex and becomes slightly bidentate in age, and the margins are scarcely serrulate.

Another plant collected by him, now named *Carex geophila*, differs from the real *Carex umbellata* in having a globose perigynium body fully 1.75 mm. or more wide; the beak is not strongly 2-edged. The eastern species grouped with *Carex umbellata* have the perigynium body triangular-globose and but 1–1.5 mm. wide, while the beak is strongly 2-edged.

Another species most closely related to *Carex geophila* occurs

along the Pacific coast from San Francisco to Vancouver Island. It furnishes the basis for the reports of the occurrence of *Carex umbellata* on the Pacific coast, and specimens of it are probably also responsible for the large perigynia at times attributed to that species. This plant, which I am calling *Carex brevicaulis*, has pistillate spikes maturing 1–4 strongly pubescent perigynia and the culms are little fibrillose at base. *Carex geophila* on the other hand has pistillate spikes maturing some 5–15 puberulent perigynia and the culms are extremely fibrillose at base.

Several distinct species have been referred to *Carex umbellata* Schk. The genuine plant is distinguished by its deep green narrow erect leaves, the old reaching an extreme width of 2.5 mm., and the width of the young ones at fruiting time averaging about 1.5–1.75 mm. The cuspidate pistillate scales are normally lanceolate or narrowly ovate-lanceolate, and usually do not entirely conceal the lower part of the perigynia. The long-beaked perigynia are 3 mm. long or more and short-pubescent, and the beak is markedly bidentate.

In parts of the country, especially in the north and west, the place of *Carex umbellata* is often taken by a closely related species, the perigynia of which are smaller (3 mm. long or less) and have a short (0.5 mm. long) shallowly bidentate beak. The scales are ovate and vary from acutish to cuspidate, and in the basal spikes tend strongly to conceal the lower part of the perigynia. This plant is the var. *brevirostris* Boott; the *C. abdita* of Mr. Bicknell. My own experience is that this species occurs in limestone districts and that *Carex umbellata* is a species not found in such districts. A closely related species ranging from Missouri to Texas has also been separated.

Thoroughly distinct is the coastal plant described by Professor Fernald as var. *tonsa* (Proc. Am. Acad. **37**: 507. 1902), and by Mr. Bicknell raised to specific rank (Bull. Torrey Club **35**: 492. 1908). While the long glabrous perigynia make it well marked, the wide stiff spreading leaves referred to by Mr. Bicknell are even more characteristic, and in the field distinguish the plant at a distance from *Carex umbellata* when growing with it. *Carex tonsa* is an abundant species in parts of the pine barren country of New Jersey.

The main distinctions between those members of the Montanae which are here discussed and which differ from all the other members of the group in having the pistillate spikes or some of them on short culms or on basal peduncles and so hidden among the leaves, may be summarized as follows:

I. Perigynia finely many-nerved as well as strongly 2-keeled.
  Scales purplish-tinged, obtuse to cuspidate; perigynium body globose; staminate spikes many-flowered; basal pistillate spikes on elongated, very slender peduncles. 1. *C. globosa.*
  Scales reddish-brown tinged, cuspidate or long-awned; perigynium body oval; staminate spikes few-flowered; basal pistillate spikes on short erect peduncles. 2. *C. Brainerdii.*

II. Perigynia strongly 2-keeled, otherwise nerveless (except at times obscurely coarsely nerved at base).
  A. Pistillate and staminate spikes closely contiguous (the culms often very short).
    Achenes normally triangular; scales strongly dark-margined; stolons short, ascending; culms strongly fibrillose at base. 3. *C. nigro-marginata.*
    Achenes normally lenticular; scales at most moderately dark-margined; stolons long, horizontal; culms little fibrillose at base. 4. *C. floridana.*
  B. Lower pistillate spikes widely separate (on subradical peduncles).
    Bract of lowest non-basal pistillate spike leaflet-like, exceeding culm; if at all colored, purplish-brown tinged at base.
      Rootstock slender; culms normally loosely cespitose (perigynia 2.5 mm. long, short-beaked, shallowly bidentate; staminate spike 2.5 mm. long, inconspicuous); northeastern species. 5. *C. deflexa.*
      Rootstock stout; culms densely cespitose; western species.
        Upper pistillate spikes normally several- to many-flowered; perigynium beak bidentate, the margins ciliate-serrulate.
          Perigynia 2.5–3 mm. long, the beak 0.25–0.75 mm. long, shallowly bidentate. 6. *C. brevipes.*
          Perigynia 3–4.5 mm. long, the beak longer, bidentate. 7. *C. Rossii.*
        Upper pistillate spikes 1–3-flowered; perigynium beak obliquely cut, in age bidentulate; the margins little if at all ciliate-serrulate (New Mexico). 8. *C. pityophila.*
    Bract of lowest non-basal pistillate spike, if present, squamiform and shorter than culm; or, if longer, auriculate and strongly reddish-brown tinged at base.

Perigynium body globose, 1.75 mm. or more wide; beak not strongly 2-edged.
Pistillate spikes with 5–15 puberulent perigynia; culms extremely fibrillose at base (New Mexico). 9. *C. geophila.*
Pistillate spikes with 1–4 strongly pubescent perigynia; culms little fibrillose at base (Pacific slope). 10. *C. brevicaulis.*
Perigynium body triangular-globose, 1–1.5 mm. wide; beak strongly 2-edged.
Perigynia 2.5–4 mm. long, pubescent; leaf-blades slender, light green, ascending, 1.5–3 mm. wide.
Short-stoloniferous, the new shoots phyllopodic, the sheaths rarely filamentose (perigynium beak very short; achenes roughened). 11. *C. microrhyncha.*
Densely cespitose, the new shoots aphyllopodic, erect-ascending, the sheaths filamentose.
Perigynia 2.5–3 mm. long, the beak less than half length of body; achenes brownish, shining, minutely pitted, orbicular-obovoid. 12. *C. abdita.*
Perigynia 3.25–4.25 mm. long, the beak more than half length of body; achenes grayish black, dull, minutely roughened, oblong-obovoid. 13. *C. umbellata.*
Perigynia 3.5–4.5 mm. long, glabrous except long beak; leaf blades stiff, deep green, spreading, 2.5–4 mm. wide. 14. *C. tonsa.*

1. CAREX GLOBOSA Boott, Proc. Linn. Soc. 1: 259. 1845

Carex umbellata var. *globosa* (Boott) Kükenth. in Engler, Pflanzenreich 4^{20}: 453. 1909.

Clumps medium-sized, from elongated slender rootstocks, stoloniferous, the culms 15–35 cm. high, phyllopodic, slender, exceeding leaves, roughened on angles above, strongly fibrillose and more or less reddened at base. Leaves with well-developed blades five to eight to a fertile culm, the lowest clustered, the upper more or less widely separate, the blades flat with revolute margins, 1.5–2.5 mm. wide, varying in length from 3 cm. to 3 dm. (on sterile culms), attenuate-pointed, strongly roughened; terminal spike staminate, erect, short-peduncled, 1–2 cm. long, 2.5–4 mm. wide, many-flowered, the scales oblong-obovate, obtuse or acute, purplish brown with lighter center and hyaline margins; pistillate spikes two or three (with additional basal ones on long capillary

peduncles), approximate, erect, sessile or a little peduncled, 5–10 mm. long, 4–8 mm. wide, short-oblong or suborbicular, containing 4–10 ascending, rather closely arranged perigynia in few ranks; bracts leaflet-like, shorter than to a little exceeding inflorescence, little sheathing, occasionally with a purplish tinge at base; scales ovate, obtuse to cuspidate, purplish with lighter center and hyaline margins, somewhat wider and longer than perigynia; perigynia 5 mm. long, the body globose, 2.25 mm. wide, puberulent or short-pubescent, 3-angled, noticeably nerved, abruptly narrowed to a prominent stipitate base and abruptly beaked at apex, the beak 0.75–1.25 mm. long, strongly bidentate; achenes obtusely triangular, closely fitting within perigynia, short-obovoid, 2 mm. long; stigmas three.

All specimens seen referable to this species are from the coastal counties of California and the islands off the coast. The range so shown is from Santa Cruz Island and Santa Barbara north as far as Sonoma County. The specimens from the Yosemite Valley referred to this species seem more properly referable to the following species.

SPECIMENS EXAMINED:

CALIFORNIA: Oakland, *Bolander* (C., L. S.*); "California," *Bolander*, 1865 (L. S.); Oakland, *Bolander 20* (H.); Oakland, *Bolander 2295*, May, 1866 (H.); Island of Santa Cruz, *Brandegee*, Apr. 1888 (N. Y.); Monterey County, *Davy 7366* (P.); Sonoma County, *Congdon 84*, May 29, 1892 (P.); Mt. Tamalpais, Marin County, *Heller 5716*, June 18, 1902 (L. S., N. Y.); San Diego, *Brandegee*, 1889 (N. Y.); Sonoma County, *Congdon*, May 30, 1895 (L. S.); Santa Lucia Mts., Monterey County, *Davy 7724*, May, June, 1901 (H.); Santa Barbara, *Brewer 303* (H.; L. S.); *Brown 370*, June 1897 (N. Y.); Redwoods, Marin Co., *Bolander V+W*, 1866 (C.).

2. **Carex Brainerdii** sp. nov.

In large clumps from slender, elongated rootstocks, the culms from very short to 15 cm. high, phyllopodic, reddened and slightly

* Key to the abbreviations of the names of herbaria used in the present paper: H., Harvard University; L. S., Leland Stanford Junior University; N. Y., New York Botanical Garden; P., S. B. Parish; B., Ezra Brainerd; K. M., Kenneth K. Mackenzie; D. C., Geological Survey of Canada; N., U. S. National; C., Columbia University; Piper, C. V. Piper.

fibrillose at base, much exceeded by leaves, slender, very rough on the sharp angles; sterile shoots strongly aphyllopodic. Leaves with well-developed blades four to eight to a fertile culm, the blades flat with slightly revolute margins, 1.5–3 mm. wide, those of the fertile culms short, of the sterile up to 25 cm. long, much roughened on both sides and averaging wider than those of the fertile; terminal spike slender, staminate, 5–8 mm. long, about 0.5 mm. wide, sessile or short-peduncled, few-flowered, the scales lanceolate or ovate-lanceolate, acuminate with 1–3-nerved green center and broad hyaline margins richly chestnut-tinged; pistillate spikes 4–6, 1–4-flowered, the upper 2 or 3 approximate, sessile or short-peduncled, the others basal, widely separated and strongly peduncled (the erect peduncles not much elongated), the zigzag rachis often terminating in a sterile flower; bracts of upper spikes well-developed, green, hyaline-margined and chestnut-tinged, all or only the lowest exceeding inflorescence, the lower more or less strongly sheathing, the upper sheathless or nearly so; scales ovate or ovate-lanceolate, cuspidate or long-awned with several-nerved green center, and with wide, strongly hyaline reddish-brown tinged margins, usually slightly longer but narrower than perigynia; perigynia softly short-pubescent, green, usually reddish-brown tinged, 4.5 mm. long, the body oval, 2.5 mm. long, 1.75 mm. wide, strongly 2-ribbed, finely many-nerved on outer face, nearly orbicular in cross-section, strongly stipitate (1 mm.), abruptly contracted into the serrulate, hyaline-tipped, bidentate beak 1 mm. long; achenes triangular with strongly convex sides, closely enveloped by perigynia, 2.25 mm. long, nearly 1.75 mm. wide, truncate at apex, round-tapering at base; style slender, not enlarged at base, readily detached; stigmas three.

The type specimen (herb. Brainerd) of this distinct plant was collected by Dr. Ezra Brainerd (*121*) in El Dorado County, California, on July 19, 1897, on a mountain north of Slippery Ford in the Sierra Nevada Mountains. A duplicate of the type is in the Gray Herbarium. *Bolander 6196*, collected in 1866 in the Yosemite Valley (H.; L. S.), a specimen collected by Mrs. Austin, in 1877, in Plumer County (H.), and *H. E. Brown 370*, collected near Sisson, Siskiyou County, California (N. Y.) are probably to be referred to this species. None of these specimens, however, is in very good condition.

3. CAREX NIGRO-MARGINATA Schwein. Ann. Lyc. N. Y. 1: 68. 1824

Carex lucorum var. *nigro-marginata* Chapm. Fl. S. E. U. S. 539. 1860.

Densely cespitose, the stolon short, ascending; culms 2–10 cm. high, much exceeded by the leaves, triangular, rough on the angles, very strongly fibrillose at base, several together with a common cluster of leaves at the base. Leaves numerous and conspicuous, the blades from very short to 35 cm. long, 2–4 mm. wide, flat, very rough, the mid-nerve prominent; staminate spike sessile, 5–8 mm. long, 2–3 mm. wide, the ovate scales obtusish, brownish with greenish midrib and narrow hyaline margin; pistillate spikes two or three, sessile, erect, contiguous or the lower slightly separate, the upper at the base of the sessile staminate spike, orbicular or ovoid-orbicular, 4–7 mm. long, 3–5 mm. wide, closely flowered, with about 6–15 ascending perigynia; bract of lower spike well developed, green, attenuate, 1.5 mm. wide at base, 5–25 mm. long, and from shorter than to exceeding the inflorescence, the upper bracts similar but shorter; scales ovate, acutish to short-cuspidate, from slightly shorter to slightly longer than the perigynia, with a broad strip of green in the center and conspicuous brownish black margin, or at times in immature specimens the brownish black margin narrow and inconspicuous; perigynia 3.5 mm. long, the body oval, 1.75 mm. long, tapering into the stipitate base 0.75 mm. long, the beak 1 mm. long, the body compressed-orbicular and somewhat obscurely triangular in cross-section, 1 mm. wide, narrowly ridged along the sides, otherwise nerveless, it and the beak minutely puberulent, the beak bidentate; achenes short-triangular, 1.5 mm. long, closely fitted to the perigynia; stigmas three.

Differs from *Carex floridana* in (1) its normally triangular achenes, (2) strongly dark-margined scales, and (3) often stiff culms, which are (4) strongly fibrillose at base, and (5) in its short ascending stolons instead of long creeping ones, thus making the plant more densely cespitose.

Forms of *Carex varia* Muhl. in which the leaves much exceed the culms may key into this species or the following one. Their narrow slender leaf-blades, and the lack of dark margins to their scales distinguish such specimens from the present species, and the absence of the long stolons and the lenticular achenes of *Carex floridana* serve to distinguish that species.

SPECIMENS EXAMINED:

NEW YORK: Babylon, *Leggett*, May 21, 1869 (C).

NEW JERSEY: Landisville, Atlantic Co., *Gross*, 1872+1883 (N. Y.) and May 28, 1898 (K. M.); Tuckerton, *Mackenzie*,

May, 1911 (K. M.); South Lakewood, *Mackenzie 4536*, May 15, 1910 (K. M.); Milford, *Porter*, May 27, 1867+1868 (N. Y.); Lakewood, *Torrey Club*, May 28, 1898 (N. Y.); Holland Station, *Garber*, June, 1868 (C); "New Jersey," *Smith* (B).

PENNSYLVANIA: Monroe, Bucks County, *Ruth*, May, 1885 (N. Y.); French Creek, *Brinton*, May 22, 1892 (C).

DELAWARE: Centreville, *Commons*, May, 1864 (N. Y.).

DISTRICT OF COLUMBIA: *Steele*, April 29, 1899 (K. M.); *M. A. Curtis*, 1845 (C).

NORTH CAROLINA: *M. A. Curtis* (N. Y.); Chapel Hill, *Ashe 3006* (N. Y.), April, 1897 (B); Salem, *Schweinitz* (C); "North Carolina," *Chapman* (C); *Hunter* (C); Tryon, *Brainerd*, April 14, 1909 (B).

SOUTH CAROLINA: Greenville, *Mackenzie 2991*, April 2, 1908 (K. M.); Clemson, Oconee County, *House 3150*, March 20, 1907 (N. Y.).

ALABAMA: Auburn, *Earle*, April 10, 1901 (N. Y.); "Alabama," *Peters*, 1867 (N. Y.).

LOUISIANA: *Leavenworth*, 1845 (C).

TENNESSEE: Broad River, *Rugel* (D. C.).

ARKANSAS: *Leavenworth*, 1845 (C).

MISSOURI: Campbell, *Bush 6597*, April 19, 1912 (K. M.).

4. CAREX FLORIDANA Schwein. Ann. Lyc. N. Y. 1: 66. 1824

Carex lucorum var. *floridana* Chapm. Fl. S. E. U. S. 539. 1860.

Carex nigro-marginata var. *subdigyna* Böckl. Linnaea 41: 220. 1877.

Carex nigro-marginata var. *floridana* (Schwein.) Kükenth. in Engler, Pflanzenreich 4^{20}: 444. 1909.

Culms very slender, or capillary, erect or spreading, from very short to 2 dm. high, roughened on the angles, exceeded by the leaves, coming up in small clumps and long-stoloniferous, slightly filamentose at base. Leaves largely basal, those on the culms abortive or very short, the basal leaves 2–3 dm. long, 1–2 mm. wide, flat or somewhat involute (especially near the base), more or less glaucous and roughened; staminate spike one, terminal (but exceeded by the contiguous pistillate spikes), very short and inconspicuous, few-flowered, sessile, 3–5 mm. long, 0.75 mm. wide, the closely appressed scales lanceolate, obtuse, with green midrib and white hyaline margins; pistillate spikes two, sessile, very

close together, short-oblong, 4–8 mm. long, 2.5–4 mm. wide, 4–8-flowered, the perigynia appressed-ascending; bracts lanceolate or ovate-lanceolate, white-hyaline with green midrib, acuminate or cuspidate, shorter than the subtended spike; scales oblong or ovate-oblong, acuminate to obtusish, white-hyaline with green midrib, rather wider but shorter than the perigynia; perigynia puberulent, spindle-shaped, 3.25 mm. long, the body oval, compressed-orbicular in cross-section, 1.5 mm. long, 0.75 mm. broad, tapering to the stipitate base 1 mm. long, and rather abruptly into the slender beak 0.75 mm. long, the orifice entire or nearly so, the body nerveless except for the prominent decurrent edges of the beak; achenes normally lenticular, closely fitting the perigynia, the face oblong-elliptic, 1.75–2 mm. long, 1 mm. wide; stigmas two.

SPECIMENS EXAMINED:

GEORGIA: Rocky Comfort Creek, Louisville, Jefferson Co., *Harper 2105*, April 9, 1904 (N. Y.).

FLORIDA: Jacksonville, *Curtiss 4128*, April 3, 1893 (C), *4639*, March 24, 1894 (C), *6127*, March 31, 1898 (K. M.); Hibernia, *Canby*, March 1869 (C); "Florida," *Chapman* (N. Y. and C); "Florida," *Keeler* (C); Banks of Little River, *Chapman* (C); West Florida, *Chapman*, 1836 (C); Apalachicola, *Biltmore 1783* (N. Y.); "Florida," *Chapman*, from Dr. Lemann, 1847 (N. Y. ex herb. Boott).

LOUISIANA: Jackson, *Ingalls*, February (C); *Hale 707* (C).

MISSISSIPPI: Ocean Springs, *Earle*, Feb. 1889, very young (N. Y.).

TEXAS: Big Sandy, *Bush 2877*, April 7, 1902 (N. Y.).

5. CAREX DEFLEXA Hornem. Plantelaere, ed. 3, 1: 938. 1821

Carex varia var. *minor* Boott, in Hook. Fl. Bor.-Am. **2**: 223 (in part). 1840.

Carex pilulifera var. *deflexa* Drej. Rev. Crit. Car. Bor. 54. 1841.

"*Carex Novae-Angliae* Schw." Boott, Ill. Car. **2**: 96 (in part). 1860.

Carex pilulifera forma, Böckl. Linnaea **41**: 216. 1877.

Carex deflexa var. *Deanei* Bailey, Mem. Torrey Club **1**: 42. 1889.

Clumps small or medium-sized, stoloniferous, the rootstocks slender, horizontally creeping, branching; culms 3–10 cm. high, very slender, exceeded by the leaves, smooth, the fertile mostly phyllopodic. Fertile culms with several leaves with well-developed

blades inserted towards the base, the blades ascending, 1 mm. wide, usually less than 6 cm. long, roughened on the margins and towards the apex; leaves of sterile culms more numerous and with longer and somewhat wider blades; staminate spike solitary, erect, sessile, 2–4 mm. long, 0.5–1 mm. wide, inconspicuous and often exceeded by the closely contiguous pistillate spikes, the scales ovate-lanceolate, closely appressed, acute, straw-colored with hyaline margins and tinged with reddish brown; pistillate spikes one or two, sessile or short-peduncled, approximate, suborbicular or short-oblong, 2–4 mm. long, 3 mm. wide, containing about 2–8 ascending perigynia, normally with an additional, widely separated, basal spike; lower bract 5–10 mm. long, not sheathing and hardly colored at base; the upper much shorter; scales ovate, acute or short-acuminate, wider but shorter than the perigynia, tinged with reddish brown, the midrib green and the margins hyaline; perigynia puberulent, obovoid, obtusely triangular, nerveless or nearly so, the body 1.5 mm. long, 1 mm. wide, tapering to a stipitate base 1 mm. long, and abruptly contracted into a short (0.5 mm. long) beak with emarginate or shallowly bidentate orifice; achenes triangular (rather obtusely), short-oval, 1.5 mm. long; stigmas three.

The smaller forms of *Carex varia* Muhl. often resemble forms of *Carex deflexa* in which the basal spikes are not developed. They are, however, strongly cespitose and have squamiform bracts, which are normally hyaline-margined at base and do not usually exceed the culms.

SPECIMENS EXAMINED:

ARCTIC AMERICA: Norway House, *Richardson* (N. Y. and C.).

QUEBEC: Montmorency Falls, *Macoun 67592*, June 28, 1905 (N. Y.); Calumet, *Macoun 7405*, June 9, 1891 (D. C.).

ONTARIO: Sudbury Junction, *Macoun 30979*, May 24, 1884 (D. C.).

NEW BRUNSWICK: Kent County, *Brittain 30974*, 1888 (D. C.); Prince Edward Island, *Macoun 10702*, June 26, 1888 (D. C.).

NOVA SCOTIA: Truro, *Macoun 10704*, June 12, 1883 (D. C.).

BRITISH COLUMBIA: Latitude 54°, *Macoun 30970*, June 10, 1875 (D. C.); McCloud's Lake, *Macoun 30972*, June 24, 1875.

MAINE: Mt. Desert Island, *Faxon*, June 23, 1891 (N. Y.); Orono, *Fernald*, May 15, 1902 (N. Y.; K. M.); and May 29, 1890 (C.); Ft. Fairfield, *Fernald 149*, July 6, 1893 (C.); Mt. Desert

Island, *Rand*, June 21 and 23, 1891 (C.); Piscataquis County, *Fernald 269*, July 5, 1895 (C.).

NEW HAMPSHIRE: Franconia, *Faxon*, June 9, 1893 (N. Y.); Lisbon, *Graves*, June 10 and 13, 1893 (C.); Crawford Notch, *Faxon*, June 7, 1878 (C.); Wing Road, *Pringle*, June 4, 1878 (B).

VERMONT: Ripton, *Brainerd*, May 25, 1878 (B); June 7, 1879 (B); June 10, 1892 (B; N. Y.); Ripton, *Brainerd & Eggleston*, June 9, 1898 (K. M.); Lyndon, July 2, 1875 (N. Y.); Groton, *Pringle*, June 13, 1879 (B).

NEW YORK: Lake Placid, *Peck*, June 12, 1897 (N. Y.); White Face Mountain, *Parry*, Aug. 1851 (C.).

MASSACHUSETTS: Hawley, *Forbes*, May 30, 1905 (K. M.).

MICHIGAN: Keweenaw County, *Farwell 745*, July 1, 1890 (C.).

6. CAREX BREVIPES W. Boott, in S. Wats. Bot. Calif. **2**: 246. 1880

Carex globosa var. *brevipes* W. Boott, in S. Wats. Bot. Calif. **2**: 485. 1880.

Carex deflexa var. *Boottii* Bailey, Mem. Torrey Club **1**: 43. 1889.

Carex pilulifera var. *Novae-Angliae* F. Kurtz, Bot. Jahrb. **19**: 419. 1894.

Carex Rossii var. *brevipes* (W. Boott) Kükenth. in Engler, Pflanzenreich 4^{20}: 452. 1909.

In dense clumps from stout, matted, ascending rootstocks, not stoloniferous, the culms from very short to 18 cm. high, phyllopodic, reddish-purple tinged and more or less strongly fibrillose at base, the longer exceeding the leaves, the shorter hidden at their base, slender, roughened on the angles above; sterile culms aphyllopodic. Leaves with well-developed blades 4–8 to a fertile culm, the blades flat with slightly revolute margins, 1.5–2.5 mm. wide, up to 15 cm. long, roughened towards apex; terminal spikes staminate, slender, short-peduncled or sessile, 4–12 mm. long, 2.5 mm. wide, several–many-flowered, the scales ovate, acute or cuspidate, about 3-nerved, reddish- or light purplish-brown with lighter center and narrow hyaline margins; pistillate spikes 3–5, usually 10–20-flowered, the upper one or two approximate, from sessile to strongly peduncled, the others widely separated, basal, long-peduncled, the perigynia in several ranks, ascending; bract of lower non-basal spike leaflet-like, exceeding inflorescence, green, slightly purplish-auricled at base; scales ovate, acute to cuspidate, 1–3-nerved, green with narrow

hyaline margins and more or less strongly purplish-tinged, about the width of but shorter than mature perigynia, exposing the upper part; perigynia small, 2.5 to nearly 3 mm. long, 1.25 mm. wide, green, puberulent, the body little longer than wide, obscurely triangular in cross-section, 2-ribbed, otherwise nerveless, from short to rather strongly stipitate, abruptly contracted into the slender, minutely serrulate, slightly colored or hyaline-tipped shallowly bidentate beak 0.25–0.75 mm. long; achenes triangular with strongly convex sides closely enveloped by perigynia, nearly 2 mm. long, truncate at apex, round-tapering at base; style short and slender; stigmas three.

This species, originally collected in the Sierra Nevada Mountains of California, has no immediate relationship with *Carex globosa* Boott, to which it has been referred. As pointed out by Prof. Bailey, its real relationship is with *Carex deflexa* Hornem. and its allies. It resembles real *Carex deflexa* in its small perigynia, 2.5–3 mm. long with shallowly bidentate beak. It, however, is densely cespitose with stout rootstocks, while *Carex deflexa* is stoloniferous and has slender rootstocks. The staminate spikes in the plant of the Sierra Nevadas are more developed, the perigynia seem less strongly stipitate, the spikes are usually more flowered, and the plant is much stiffer. *Carex Rossii*, with larger deeply bidentate perigynia, seems constantly different.

SPECIMENS EXAMINED:

CALIFORNIA: "Lake Tahoe to Bear Valley," *Kellogg*, and "Rocky Mts. California," *Kellogg* (type sheets in Gray Herbarium); Sierra Nevada, *Braman & Kellogg*, June 9, 1870 (N. Y.); Sierra Nevada Mts., El Dorado County, *Brainerd 116*, July 19, 1897 (H; Brainerd).

WASHINGTON: Wenatchee Mts., Kittitas County, *Elmer 453*, June 28, 1897 (Piper).

7. CAREX ROSSII Boott, in Hook. Fl. Bor.-Am. **2**: 222. 1840

Carex Novae-Angliae var. *Rossii* Bailey, Bot. Gaz. **10**: 207. 1885.

Carex deflexa var. *Rossii* and var. *media* Bailey, Mem. Torrey Club **1**: 43. 1889.

Carex Novae-Angliae var. *deflexa* Bailey, Proc. Am. Acad. **22**: 124. 1886.

Carex deflexa var. *Farwellii* Brit., Brit. & Br. Ill. Fl. **1**: 334. 1896.

Carex Farwellii (Brit.) Mackenzie, Bull. Torrey Club **37**: 244. 1910.

Clumps medium-sized, densely or loosely cespitose, hardly stoloniferous, the rootstocks ascending; culms 5–20 cm. high, slender, usually exceeding the leaves, smooth or slightly roughened under the inflorescence, aphyllopodic or phyllopodic; basal spikes usually numerous. Fertile culms with several leaves with well-developed blades inserted towards the base, the blades ascending, 1–2 mm. wide, usually less than 6 cm. long, roughened on the margins and towards the apex; leaves of sterile culms more numerous and with longer and somewhat wider blades; staminate spike sessile or nearly so, erect, 3–8 mm. long, 1 mm. wide, exceeding the contiguous pistillate spike, the scales ovate-oblong, closely appressed, acutish, with green midrib and hyaline margins and strongly tinged with reddish brown; pistillate spikes one or two, sessile or short-peduncled (and with some additional widely separated basal ones), approximate or somewhat separate, suborbicular or short-oblong, 3–5 mm. long, 3–4 mm. wide, containing 3–10 ascending perigynia; lower bract 0.5–5 cm. long, not sheathing and hardly colored at base; the upper much shorter; scales ovate, acute to acuminate, or cuspidate, wider but shorter than the mature perigynia, strongly tinged with reddish- or purplish-brown, the midrib green and the margins hyaline; perigynia short-pubescent, 3–4.5 mm. long, obovoid, obtusely triangular, 2-ribbed but otherwise nerveless or nearly so, the body 1.5–2.5 mm. long, 1 mm. wide, tapering to a stipitate base 0.5–1.5 mm. long, and abruptly contracted into a bidentate beak 0.75–1.25 mm. long; achenes triangular (rather obtusely), short-oval, 1.5 mm. long; stigmas three.

This characteristic species of the western mountains has been given a great deal of study by me in an endeavor to ascertain definitely whether it represented an aggregate of more than one species or not. As a result I have come to the conclusion that but one variable species is represented and that the notable variations shown in individual plants are to be explained by environmental conditions. The species varies from densely cespitose in alpine or subalpine situations to loosely cespitose in more protected localities; these more loosely cespitose plants have the leaf-blades of the sterile culms much more developed and in all respects show a stronger vegetative growth; the scales of the basal spikes are inclined to be strongly cuspidate and the perigynia range in length from 3.75 to 4.5 mm. with a beak as long as the body. Such plants answer to *Carex Farwellii* and are quite dif-

ferent in appearance from the densely cespitose plants with much less developed vegetative growth, acute scales, and perigynia ranging from 3 to 4 mm. in length, with beak shorter than the body, which represent the other extreme of the series. However, all kinds of intermediate combinations appear, and make separation impossible except arbitrarily.

Other plants with narrow involute leaves collected in very dry situations also look quite different, but their peculiar aspect seems wholly due to their dried-up condition, as no structural differences have been found.

The species as here treated ranges from Vancouver Island and the Canadian Rockies south through Washington and Oregon to the higher Sierras of California and eastward in the higher mountains of Nevada and Utah. It seems common in Colorado, Wyoming, Montana, and Idaho. It has been found in northern Michigan. It is to be expected in northern New Mexico and possibly Arizona, and its northern range in western Canada is yet to be ascertained.

SPECIMENS EXAMINED:

CANADA: Rocky Mt. Park, *Macoun 64056*, July 8, 1904 (N. Y.); between Kettle and Columbia Rivers, *Macoun 63318*, June 6, 1902, and *63319*, July 9, 1902 (N. Y.), and *63320*, July 19, 1902 (N. Y.); Nanaimo, Vancouver Island, *Macoun 76742*, July 13, 1908 (N. Y.); Medicine Hat, Assiniboia, *Macoun 7402*, June 4, 1894 (C.); Mountain Post, Assiniboia, *Macoun 10780*, June 11, 1895 (N. Y., H); Revelstoke, *Shaw 834*, July 6, 1905 (N. Y.); Revelstoke, *Macoun 57A*, May 19, 1890 (C.); Lake Louise, *Macoun 64055*, July 20, 1904; Mt. Arrowsmith, *Rosendahl 2023*, June 28, 1907 (N. Y., H); Qu'Appelle Valley, *Macoun 49*, June 22, 1879 (H); Yale, *Macoun*, June 17, 1876 (H); Grand Valley, *Macoun 261*, June 16, 1880 (H); Trail to Asalkan Glacier, British Columbia, *Brainerd*, Aug. 11, 1897 (B); Vancouver, *Macoun*, July 27, 1887 (B); Calgary, *Macoun 25460*, June 7, 1897 (D. C.); Mt. Arrowsmith, Vancouver Island, *Macoun 30969*, July 17, 1887 (D. C.); Rogers Pass, Selkirk Mts., *Macoun 30968*, July 29, 1890 (D. C.); Elbow River, Rocky Mts., *Macoun 25461*, July 15, 1897 (D. C.); Esquimault, Vancouver Island, *Macoun 376*, June 9, 1893, and

Mt. Benson, *Macoun 377*, July 10, 1893 (D. C.); Nanaimo and Horne Lake, Vancouver Island, *Macoun 20286*, June 4, 1887, and *10706*, July 25, 1887 (D. C.); Kananaskis, Rocky Mts., *Macoun 32016*, June 15, 1885 (D. C.); Spy Hill, Saskatchewan, *Macoun 72789*, July 1, 1906 (D. C.); Clearwater River, *Macoun 32007*, July 8, 1888 (D. C.); Lytton, British Columbia, *Macoun 32008*, April 17, 1889 (D. C.); New Westminster Junction, British Columbia, *Macoun 80878*, April 19, 1889 (D. C.).

WASHINGTON: Bingen, *Suksdorf*, May 12, 1909 (N. Y.); Mt. Paddo, *Suksdorf*, Aug. 9, 1909 (N. Y.); Olympic Mts., *Elmer 2718*, June 1900 (N. Y., Piper); Mt. Rainier, *Piper 2537*, Aug. 15, 1895 (Piper, N. Y.); West Klickitat County, *Suksdorf 276*, April 30, 1885 (C.); "Washington," *Henderson*, 1892 (C.); Mt. Adams, *Howell*, Aug. 15, 1882 (H); Cascade Mts., *Allen 168*, June 4, 1895 (N. Y., H, Piper); Klickitat River, *Suksdorf 48*, June 2, 1883 (H); Cascade Mts., *Vasey*, 1889 (Piper); Whitman County, *Piper 3094*, July 20, 1899 (Piper); Blue Mts., *Horner 480*, July 29, 1897 (Piper); Mt. Rainier, *Piper 2552*, Aug. 1895 (Piper); Mt. Adams, *Henderson 2094*, Aug. 10, 1892 (Piper); Olympia, *Henderson*, 1892 (Piper); Hangman Creek, Spokane County, *Sandberg & Leiberg 30*, May 17, 1893 (Piper); Wenatchee, *Brandegee 1145*, 1883 (D. C.).

OREGON: Union County, *Cusick 1322*, 1886 (Piper); "Oregon," *Cusick* (Piper); Wallowa Mts., *Sheldon 8535*, July 12, 1897 (K. M.); Lake County, *Eggleston 6850*, June 5, 1911 (N); Mt. Adams, *Chickering*, Aug. 1882 (D. C.).

CALIFORNIA: Sierra Nevada, *Kellogg* (N. Y.); Cisco, Sierra Nevada, *Kellogg*, June 19, 1870 (H); Hat Creek, Shasta County, *Eggleston 7382, 7434, 7435*, July 31, 1911 (N) also *7485*, Aug. 2, 1911 (N); Summit, Placer County, *Heller 9853*, July 16, 1909 (K. M.); Pyramid Peak, El Dorado County, *Hall & Chandler 4749*, Aug. 1–2, 1903 (H).

UTAH: Big Cottonwood Canyon, Salt Lake Co., *Garrett 1658*, Aug. 21, 1905 (N. Y.); Marysvale, *Jones 5343*, May 31, 1899 (N. Y., K. M.); Alta, *Jones 1204*, Aug. 7, 1879 (C.); Hornwood Canyon, *Watson 1260*, July 1869 (C.).

IDAHO: Kootenai County, *Sandberg, MacDougal & Heller 234*, May 23, 1892, and *841*, Aug. 5, 1892 (N. Y.); Nez Perces County, *A. A. & E. G. Heller 3388*, July 9, 1896 (C., Piper); Kootenai

County, *Sandberg*, July 1887 (N. Y.); Sweetwater, *Heller*, July 1896 (K. M.).

MONTANA: Bozeman, *Flodman 289*, July 7, 1896 (N. Y.); Little Belt Mts., *Flodman 288*, Aug. 1896 (N. Y.); Helena, *Kelsey*, July 12, 1892 (N. Y.); Little Belt Mts., *Rydberg 3377, 3892*, Aug. 1896 (N. Y.); Spanish Basin, Madison Range, *Flodman 287*, July 18, 1896 (N. Y.).

COLORADO: *Vasey* (N. Y.); Chamber's Lake, *Baker*, July 13, 1896 (N. Y.); La Plata Mts., *Baker, Earle & Tracy 685*, July 14, 1898 (N. Y.); Chamber's Lake, *Crandall*, July 25, 1894 (N. Y.); Chamber's Lake, *Colo. Agri. College 2549*, July 28, 1889 (N. Y.); Beaver Creek, *Colo. Agri. College 2558*, July 19, 1898 (N. Y.); Pagosa Peak, *Baker 237*, Aug. 1899 (N. Y.); Cameron Pass, *Baker*, July 14, 1896 (N. Y., C.); Middle Park, *Beardslee*, Aug. 1892 (N. Y.); Colorado Springs, *Jones 59*, May 14, 1878 (N. Y., C., B); Silver Plume, *Rydberg 2416*, and *Shear 669*, Aug. 21, 1895 (N. Y.); Twin Lakes, *Wolfe 1058*, 1873 (C.); Mt. Helen, *Mackenzie 307*, Aug. 1901 (K. M.).

WYOMING: Big Horn Mts., Sheridan County, *Tweedy 2246*, July 1899 (N. Y.); Black Rock Creek, Teton Forest Reserve, *Tweedy 401*, Aug. 1897 (N. Y.); Teton Pass, *Merrill & Wilcox 1249*, July 13, 1901 (N. Y.); Madison Canyon, *A. & E. Nelson 6761*, Aug. 29, 1899 (N. Y.); Battle Lake, *A. Nelson 3046*, Aug. 16, 1897 (N. Y.); Yellowstone Park, *Williams*, 1888 (N. Y.); Yellowstone Park, *A. & E. Nelson 6361*, Aug. 8, 1899 (N. Y., K. M.); La Plata Mines, *A. & E. Nelson 5148*, Aug. 25, 1898 (K. M.); Ten Sleep Lakes, *Nelson 2972*, Aug. 19, 1897 (K. M.).

MICHIGAN: Clifton, Keweenaw Co., *Farwell 244*, June, 1890 (Col., H).

8. **Carex pityophila** sp. nov.

In large dense clumps from slender tough ascending forking rootstocks, not stoloniferous, the culms from very short to 15 cm. high, aphyllopodic, reddish brown and more or less fibrillose at base, usually shorter than leaves, slender, very rough on the sharp angles; sterile culms aphyllopodic. Leaves with well-developed blades 5–10 to a fertile culm, the blades involute but flat above with slightly revolute margins, slender, at flowering time 0.75–1.5 mm. wide, 2–25 cm. long, much roughened; terminal spike staminate, slender, 4–8 mm. long, 1.5 mm. wide, more or less

strongly peduncled, few–several-flowered, the scales ovate or obovate, obtuse to acute, 1–3-nerved, purplish brown with lighter midvein and conspicuous hyaline margins; pistillate spikes 2–5, usually 2–5-flowered, the upper one or two approximate or little separate, sessile or peduncled, the others widely separate, basal and strongly peduncled, the perigynia erect-ascending, the rachis zigzag; bract of upper spike green, scarcely sheathing, slightly purplish-tinged at base, normally exceeding inflorescence; scales ovate, acute to short-cuspidate, with several-nerved green center and hyaline margins and more or less strongly purplish-brown tinged, nearly as long and nearly as wide as, but not enveloping or concealing perigynia; perigynia sparingly puberulent, green, 3.5–4.5 mm. long, the body short- to long-oval, 2.25–3 mm. long, 1.75 mm. wide, 2-ribbed and otherwise nerveless or nearly so, triangular-suborbicular in cross-section, strongly stipitate (0.75–1 mm.), abruptly contracted into the scarcely ciliate-serrulate, hyaline-tipped, obliquely cut, in age shallowly bidentate beak, 0.75–1 mm. long; achenes triangular with strongly convex sides, closely enveloped by perigynia, 2–2.75 mm. long, nearly 1.75 mm. wide, truncate and slightly apiculate at apex, rounded at base; style slender, not enlarged at base, readily detached; stigmas three.

The type specimen was collected by Mr. W. W. Eggleston (*6605*) southeast of Tierra Amarilla, Rio Arriba County, New Mexico, in the piñon belt at an altitude of 2,320 meters in the spring of 1911 (sheet 660821, United States National Herbarium). His numbers *6536*, *6540*, *6542* and *6610*, collected in the same locality, also represent this species. Fendler's *889* collected in New Mexico in 1847 (H) also belongs here.

Carex geophila differs in the characters given in the key and in addition the present species has narrower leaves, more slender staminate spikes, few-flowered pistillate spikes, strongly reddened culm bases and scarcely ciliate-serrulate perigynium beak.

9. **Carex geophila** sp. nov.

In large very dense clumps from tough, rather slender, much branched rootstocks, not stoloniferous, the culms from very short to 10 cm. high, phyllopodic, brownish and very conspicuously and strongly fibrillose at base, much shorter than and mostly hidden among bases of leaves, slender, very rough on the sharp angles; sterile culms strongly aphyllopodic. Leaves with well-developed blades 5–10 to a fertile culm, the blades flat with slightly revolute margins, 1.5–2.5 mm. wide, 2–15 cm.

long, much roughened; terminal spike staminate, slender, 5–9 mm. long, 2.5 mm. wide, more or less strongly peduncled, several–many-flowered, the scales ovate, acute or short-acuminate, many-striate, purplish brown with lighter center and conspicuous white-hyaline margins; pistillate spikes 2–5, usually 5–15-flowered, the upper one or two usually approximate, sessile or short-peduncled (sometimes absent), the others widely separated, basal and strongly peduncled, the perigynia in several ranks, ascending; bract of upper spike (where spike is present) well developed, green, somewhat sheathing, slightly brownish-red tinged, shorter than inflorescence; scales ovate, acute to short-cuspidate, those of the upper spikes reddish brown with 3-nerved green center and white-hyaline margins, those of lower spikes slightly if at all reddish-brown tinged, all from slightly shorter to slightly longer and wider than but not enveloping or nearly concealing perigynia; perigynia puberulent, green, 3.25–4 mm. long, the body suborbicular, 2.25–2.5 mm. long, 1.75 mm. wide, 2-ribbed, otherwise nerveless or more or less strongly nerved at base on one face, nearly orbicular in cross-section, strongly stipitate (0.5–0.75 mm.), abruptly contracted into the serrulate, slightly hyaline or purplish-tipped bidentate beak, 0.5–0.75 mm. long; achenes triangular with strongly convex sides, closely enveloped by perigynia, about 2.25 mm. long, nearly 1.75 mm. wide, truncate and slightly apiculate at apex, round-tapering at base; style slender, not enlarged at base, readily detached; stigmas three.

The type specimen, collected by Mr. W. W. Eggleston (*6584*) at Tierra Amarilla, Rio Arriba County, New Mexico, in the spring of 1911, is in the United States National Herbarium (sheet 660800). His numbers *6614*, *6474*, *6466*, *6550*, *6556*, *6458*, and *6593* from the same locality also belong here, as does also his *6655* collected near Chama, Rio Arriba County. The species is also represented by a specimen in the Gray Herbarium, collected by Dr. Greene April 22, 1880 (deep shady canyon of Mineral Creek in the Mogollon Mountains).

10. **Carex brevicaulis** sp. nov.

In dense clumps, stoloniferous, the culms phyllopodic, 5–10 cm. high, slender, exceeded by the leaves, sharply triangular, very rough on the angles, reddish brown and more or less fibrillose at base. Leaves with well-developed blades 6–10 to a fertile culm, clustered near base, the blades flat, 1.5–3.5 mm. wide, usually 2.5–7.5 cm. long, roughened above and towards apex; leaf-blades of sterile culms 5–12 cm. long; terminal spike stam-

inate, few-flowered, short-peduncled, 6–9 mm. long, 1.5–2 mm. wide, the scales narrowly ovate, acute to short-cuspidate, reddish brown with light-colored midrib and center and white-hyaline, non-ciliate margins; lateral spikes 2, 3 or 4, pistillate, 4–6 mm. long and nearly as wide, the uppermost sessile near base of staminate, the second (if present) sessile and somewhat remote, the others far remote, basal, slender-peduncled, the maturing perigynia 1–4, erect-ascending, the upper flowers not developing; bract of upper spikes leaflet-like, shorter than or rarely slightly exceeding culm, widened at base into reddish brown auricles with hyaline margins; scales ovate, acute to short-cuspidate, reddish brown with light-colored midrib and center and white-hyaline, non-ciliate margins, narrower and shorter than the mature perigynia; perigynia about 4 mm. long, loosely short-pubescent, more or less yellowish-brown tinged, stipitate, the body globose, 2.25 mm. wide, 2-ribbed, abruptly contracted into the slender serrulate, rather shallowly bidentate beak 1 mm. long; achenes triangular-globose, the sides strongly convex, closely enveloped by perigynia, 2 mm. wide and slightly longer, abruptly rounded at base and apex, slightly stipitate; style slender, enlarged at base, deciduous, short; stigmas three.

SPECIMENS EXAMINED:

BRITISH COLUMBIA: Victoria, *Macoun 76706*, June 12, 1908 (N. Y.); Vancouver, *Macoun*, May 30, 1873 (H); *Macoun 32014*, May 8, 1875 (D. C.).

WASHINGTON: Whidbey Island, *Gardner 343*, May 29, 1897 (Piper).

OREGON: Yaquina Bay, *Howell 2994*, May 1886, type (N. Y.); Wilkes Exped. 1834–1842 (C.).

CALIFORNIA: San Francisco, *Kellogg*, May 1880 (N. Y.).

11. **Carex microrhyncha** sp. nov.

In large stools, spreading by short stolons; culms from very short to 15 cm. high, mostly much exceeded by the leaves, slender, triangular, rough on the angles, reddish-brown tinged and strongly fibrillose at base, phyllopodic; sterile culms phyllopodic, terminating the short stolons, their sheaths little if at all filamentose. Leaves numerous, erect or ascending, light green, from very short to 20 or 30 cm. in length, at flowering time 1.5–2.5 mm. wide, in age up to 3 mm. wide, flat with somewhat revolute margins, very rough above; terminal spike staminate, sessile or short-peduncled, 5–10 mm. long, 1.5–2.5 mm. wide, the scales obovate,

obtuse or acute, reddish brown with lighter midvein and hyaline margins; pistillate spike usually present at base of staminate, sessile or short-peduncled, globose-oblong, 3.5 mm. wide, 4–7 mm. long, its bract squamiform, reddish-brown tinged and exceeded by culm, the basal spikes 2 or 3, subglobose, 4–6 mm. long, 3.5–4.5 mm. wide; scales broadly ovate acute or short-cuspidate, about length of but wider than perigynia and largely concealing them, strongly several-nerved, greenish or hyaline; perigynia 2.25–3.25 mm. long, the body short-oval, triangular-orbicular in cross-section, 1.25 mm. wide, short-pubescent, 2-ribbed, otherwise nerveless, tapering or contracted into a short stipitate base 0.5 mm. long, abruptly contracted into the short (0.5 mm. long) beak, less than half length of body, the beak 2-edged, hyaline-tipped, at most obscurely bidentate; achenes triangular, oblong-obovoid, filling perigynia, minutely stipitate, dull or silvery blackish, the superficial cells conspicuous, the sides convex and angles blunt and prominent; style slender; stigmas three.

This species bears such a strong superficial resemblance to *Carex abdita* Bicknell that it was not until I came to examine the achenes that I found out that the plants were distinct. The achenes in fact much more resemble those of true *Carex umbellata* Schk., as described by Mr. Bicknell (Bull. Torrey Club **35**: 491), and as the perigynia are those of *Carex abdita*, I began to doubt the excellent achene characters brought out by him. However, still further study brought out the differences shown in the key in the manner of growth and in the sterile shoots as compared both with *C. abdita* and *C. umbellata*. The perigynia, too, are much more concealed by the scales than in either of these species.

SPECIMENS EXAMINED:

MISSOURI: Dodson, Jackson County, *Mackenzie*, May 10, 1896, and May 14, 1899, type (K. M.); St. Louis, *Riehl*, 1838 (C); St. Louis County, *Eggert*, April–May, 1887 (H).

INDIAN TERRITORY: Limestone Gap, *Butler* (H).

TEXAS: Blanco River (Dew. Herb., H); "Texas," *Leavenworth* (C); Dallas, *Reverchon*, March 1877 (C).

12. CAREX ABDITA Bicknell, Bull. Torrey Club **35**: 492. 1908

Carex umbellata var. *brevirostris* Boott, Ill. Car. **2**: 99. *pl. 294*. 1860.

Very densely cespitose, culms from very short to 15 cm. high,

mostly much exceeded by the leaves, slender, triangular, rough on the angles, reddish-brown tinged and strongly fibrillose at base, phyllopodic; sterile culms aphyllopodic, erect, the sheaths filamentose. Leaves numerous, the blades erect or ascending, light green, from very short to 20 or 30 cm. in length, at flowering time about 1.5 to 2.5 mm. wide, in age up to 3 mm. wide, flat with somewhat revolute margins, very rough above; terminal spike staminate, sessile or short-peduncled, 5–10 mm. long, 1.5–2 mm. wide, the scales obovate, obtuse or acute, reddish brown with lighter midvein and hyaline margins; pistillate spike usually present at base of staminate, sessile or short-peduncled, globose-oblong, 3.5 mm. wide, 4–7 mm. long, its bract squamiform, reddish-brown tinged and exceeded by culm, the basal spikes 2 or 3, short, oblong, 5–9 mm. long, frequently staminate at apex; scales ovate, abruptly acute or acuminate, longer and wider than perigynia but not concealing them, strongly several-nerved, greenish or hyaline, the upper at least reddish-brown tinged; perigynia 2.25–3.25 mm. long, the body subglobose, triangular-orbicular in cross-section, 1.25 mm. wide, short-pubescent, 2-ribbed, otherwise nerveless, tapering or contracted into a short-stipitate base, 0.5 mm. long, abruptly contracted into the short (0.5–1 mm. long) beak, less than half length of body, the beak 2-edged, hyaline-tipped, at most obscurely bidentate; achenes triangular, orbicular-obovoid, filling perigynia, brownish, sessile, shining, irregularly pitted, the sides convex and angles sharp and narrow; style slender; stigmas three.

Differs from *Carex umbellata* in the small, short-beaked, obscurely bidentate perigynia, and in the achenes.

A northern species extending south to Delaware and Indiana.

SPECIMENS EXAMINED:

CANADA: Quesnelle, *Macoun*, May 29, 1874 (H); Norway House, *Richardson 323* (H); Rocky Mts., *Richardson* (H); Carlton House (H); Norway House, *Richardson* (H); Victoria, Vancouver Island, *Macoun 16673*, May 7, 1875 (D. C.); Fraser River Valley, *Macoun 32015*, May 18, 1875 (D. C.); "Rocky Mts.," *Drummond* (D. C.); Hastings County, Ontario, *Macoun 32019*, June 15, 1865 (D. C.).

MAINE: Vassalboro, *Fernald & Chamberlain*, May 17, 1902 (K. M.); Bangor, *Knight*, May 14, 1905 (K. M.).

VERMONT: Snake Mt., *Brainerd*, June 11, 1897 (B).

NEW HAMPSHIRE: Mt. Willard, *Faxon*, June 7 (N. Y.).

MASSACHUSETTS: Deerfield, *Cooley* (C); Boston, *W. Boott* (D. C.).

CONNECTICUT: Bridgeport, *Eames*, May 28, 1908 (N. Y.).

RHODE ISLAND: Thurber, May 1846 (N. Y.).

NEW YORK: Richmond Hill, Long Island, *Bicknell*, May 11, 1904 (N. Y.); Jamaica, *Bicknell*, May 19, 1905, type (N. Y.); Sparrow Bush, along Delaware River, *Britton*, May 30, 1903 (N. Y.); Yonkers, *E. C. Howe*, May 1876 (N. Y.); Whitesboro, Oneida County, *Haberer 5176*, June 19, 1883 (N. Y.); New York, *LeRoy* (C.).

NEW JERSEY: Hoboken, *Torrey*, May 1824 (C.); Andover Junction, *Mackenzie 4869*, May 1911 (K. M.); Columbia, *Mackenzie*, May 1913 (K. M.); Cranberry Lake, *Mackenzie 2608*, June 9, 1907 (K. M.); south of Port Jervis, *Mackenzie 4584*, May 30, 1910 (K. M.).

DELAWARE: Townsend, *Commons*, May 17, 1883 (N. Y.).

INDIANA: Ripley County, *Deam 10578*, May 19, 1912 (K. M.); Clarke County, *Deam 10494*, May 8, 1912 (K. M.); Wells County, *Deam*, April 30, 1899 (K. M.).

13. CAREX UMBELLATA Schkuhr, Willd. Sp. Pl. 4: 290. 1805

Carex umbellata var. *vicina* Dewey, Am. Jour. Sci. **10**: *pl. D. f. 13* 1826; **11**: 317. 1826.

Very densely cespitose, culms from very short to 15 or 20 cm. high, much exceeded by the leaves, triangular, rough on the angles, reddish-brown tinged and strongly fibrillose at base, phyllopodic; sterile culms aphyllopodic, erect, the sheaths filamentose. Leaves numerous and conspicuous, the blades from very short to 20 cm. long, at flowering time 1.5–2 mm. wide, in age wider, very rough, flat with somewhat revolute margins; terminal spike staminate, short-peduncled, 8–12 mm. long, 1.5–2.5 mm. wide, the scales obovate, obtuse or acute, reddish-brown with lighter midvein and hyaline margins; pistillate spike usually present at base of staminate, sessile or short-peduncled, globose-oblong, 3.5 mm. wide, 4–7 mm. long, its bract squamiform and exceeded by culm, the basal spikes oblong, 4–10 mm. long, 3.5–4.5 mm. wide; scales lance-ovate, short-cuspidate to acuminate, from slightly shorter to slightly longer and rather wider than the perigynia, but not concealing them, those on the shorter culms hyaline with green several-nerved center, those on the longer culms similar, but the margin tinged with reddish brown; perigynia 3.25–4.25 mm. long,

the body short-oval, triangular-orbicular in cross-section, about 1.75 mm. long and 1.4 mm. wide, short-pubescent, 2-ribbed, otherwise nerveless, abruptly short-(0.5 mm. long) stipitate, abruptly contracted into a beak about length of body, the beak 2-edged, hyaline-tipped, bidentate; achenes triangular, oblong-obovoid, filling perigynia, dull or silvery blackish, minutely roughened, the superficial cells conspicuous, sessile, the sides convex, and angles sharp and narrow; style slender; stigmas three.

Carex pennsylvanica Lam. and *Carex heliophila* Mackenzie at times develop pistillate spikes on subradical peduncles. The long stolons characteristic of these species afford the easiest means of distinguishing such specimens from *Carex umbellata* and its allies. It is possible that these specimens represent, to some extent at least, hybrids with the *Carex umbellata* group as they are treated by Kükenthal, but my own inclination is to regard them as above.

SPECIMENS EXAMINED:

CANADA: Bic, Rimouski County, Quebec, *Forbes*, June 23, 1905 (K. M.); Point Pleasant, Nova Scotia, *Macoun 16674*, June 18, 1883 (D. C.); Edmonton, Ontario, *White 32017*, May 24, 1893 (D. C.).

VERMONT: Middlebury, *Brainerd*, May 24, 1878, and June 9, 1891 (B); Winooski, *Brainerd*, June 5, 1897 (B); Chipman Hill, *Brainerd*, May 30, 1897 (B).

MICHIGAN: Port Huron, *Dodge*, June 3, 1894 (K. M.); Lake Harbor, *Umbach*, May 28, 1898 (K. M.); Orion, Oakland County, *Wheeler*, May 30, 1895 (C); Grand Lodge, *Wheeler 47*, May 5, 1890 (C).

MAINE: Orono, *Merrill*, June 5, 1898 (N. Y.); Orono, *Fernald*, June 30, 1890.

MASSACHUSETTS: South Ashburnham, *Forbes*, May 30, 1904; (K. M.); Manchester, *Chamberlain* (N. Y.); Cambridge, *Mrs. Britton*, May 12, 1889 (C); "Mass.," *Dewey* (D. C.).

NEW YORK: Yonkers, *E. C. Howe*, May 1880 (N. Y.); "New York," *Crawe* (C); "New York," *Gray*, 1846 (C); Highlands of New York, *Torrey* (C).

NEW JERSEY: High Point, Sussex County, *Mackenzie 4564* and *4571*, May 29, 1910 (K. M.); Tuckerton, *Mackenzie*, May 1911 (K. M.).

14. CAREX TONSA (Fernald) Bickn. Bull. Torrey Club 35: 492. 1908

Carex umbellata var. *tonsa* Fernald, Proc. Am. Acad. 37: 507. 1902.

Densely cespitose, freely short-stoloniferous; culms 2–15 cm. high, much exceeded by the leaves, sharply triangular, strongly roughened on the angles, strongly reddish-brown tinged and fibrillose at base, phyllopodic; sterile culms aphyllopodic, the sheaths little filamentose. Leaves numerous and conspicuous, the blades spreading, deep green, 2.5–4 mm. wide with revolute margins, 5–25 cm. long, rough towards the long attenuate apex; staminate spike 6–12 mm. long, 2–3 mm. wide, the obovate scales acute, reddish brown with greenish or straw-colored center and white-hyaline margin; pistillate spike occasionally present at base of staminate, sessile or nearly so, erect-ascending; basal pistillate spikes 2–3, on long slender peduncles, short-oblong, 6–10mm. long, 4.5–6 mm. wide, containing 3–20 closely packed appressed-ascending perigynia in several ranks; bract at base of uppermost spike setaceous, not sheathing, from much shorter than to slightly exceeding spike; scales conspicuous, ovate, short-cuspidate to acute, wider and from slightly shorter to slightly longer than perigynia, whitish or straw-colored hyaline, with green midrib, the upper often with purplish brown margins; perigynia 3.5–4.5 mm. long, the body broadly oval, 1.75 mm. long, 1.25 mm. wide, tapering into the stipitate base 0.75 mm. long and the beak 1.75–2.5 mm. long, the body compressed-orbicular and obscurely triangular in cross-section, 2-ribbed, otherwise nerveless or nearly so, very sparsely short-pubescent above and on the strongly 2-edged bidentate beak; achenes short-obovoid, triangular, filling perigynia, brownish, shining, pitted, the superficial cells inconspicuous, substipitate, 1.5 mm. long, closely fitting perigynia, the sides convex and angles sharp and narrow; style slender; stigmas three.

SPECIMENS EXAMINED:

CANADA: Lake Ellen, Ontario, *Macoun 32020*, July 1, 1884 (D. C.); "British N. W. America," *Richardson* (D. C.); Chalk River, Ottawa Valley, *Macoun 16675*, May 30, 1884 (D. C.); Cape à L'Aigle, Quebec, *Macoun 67594*, July 27, 1905 (D. C.); Truro, Nova Scotia, *Macoun 32018*, June 14, 1883 (D. C.).

MAINE: Orono, *Fernald*, May 15, 1902 (N. Y., K. M.); also May 29, 1890 and June 2, 1890 (C).

MICHIGAN: White Hall, *Wheeler*, June 27, 1900 (D. C.).

MASSACHUSETTS: South Dennis, *C. N. Brainerd*, May 1878 (B); Nantasket, *E. Brainerd*, June 11, 1896 (B).

RHODE ISLAND: Cumberland Mills, *Collins*, May 29, 1892 (C).

NEW YORK: Wading River, *E. S. Miller* (N. Y.); Valley Stream, *Bicknell*, May 23, 1908 (N. Y.); Woodmere, *Bicknell*, May 10, 1908 (N. Y.).

NEW JERSEY: South Lakewood, *Mackenzie 4544*, May 15, 1910 (K. M.); Tuckerton, *Mackenzie*, May 1911 (K. M.); Lakewood, *Torrey Club*, May 28, 1898 (N. Y.); "New Jersey," *Parker* (N. Y., D. C.); "New Jersey," *Knieskern* (N. Y.); Forked River, *Torrey Club*, May 29, 1896 (C); Tom's River, *Britton*, May 23, 1885 (C); Stelton, *Mackenzie 3024*, May 3, 1908 (K. M.); Yardville, *Mackenzie*, May 1913 (K. M.).

DISTRICT OF COLUMBIA: Tacoma Heights, *Williams*, March 26, 1898 (K. M.); *Holm*, May 1899 (D. C.).

NEW YORK CITY

The development and behavior of the chromosomes in the first or heterotypic mitosis of the pollen mother-cells of Allium cernuum Roth

DAVID M. MOTTIER AND MILDRED NOTHNAGEL

(WITH PLATES 23 AND 24)

It may seem to the reader of cytological literature that whoever offers a contribution upon *Allium* might well preface his remarks with an apology for so doing. However, certain favorable forms of both plants and animals will doubtless ever remain objects of investigation. On looking about for favorable material for class use, the senior author came upon a species of wild onion, common in certain localities in Indiana, namely, *Allium cernuum* Roth, a species which is regarded as more favorable than the much used *Allium Cepa*.

A study of mitotic phenomena has been made in both vegetative and microspore mother-cells, and the results obtained and conclusions reached differ so much in certain respects from those of Bonnevie ('11), as set forth in a recent contribution on *Allium Cepa*, that we have decided to present the results of our observations on the pollen mother-cells at this time, reserving an account of the process of nuclear behavior in vegetative cells for a future publication.

In describing the resting stage of the nucleus in the pollen mother-cell of *Allium Cepa*, Bonnevie ('11, 197) asserts that a number of threads radiate from a chromatin knot or lump (Chromatinknoten), being continued into the meshes of the nuclear net. "Vom Chromatinknoten sieht man eine Anzahl Fädchen, die in den Maschen des Kernnetzes ihre Fortsetzung finden, radiär ausstrahlen." With the disappearance of the anastomoses between these radiating threads, the latter gradually became more distinct throughout their entire length, at the same time appearing always zigzag or spirally twisted. Precisely the same structure is reported for the resting nucleus of somatic cells. Following this

structure there takes place (l. c. 197) a pairwise conjugation of the chromosomes, which finds its culmination in synapsis. This conjugation is accomplished by the lateral fusion in pairs of the threads radiating from the chromatin knots (l. c. fig. 20). Soon after this (l. c. 198) such nuclei become more irregular, for, in addition to the chromatin knots or lumps, there appear other dense accumulations of chromatin, so that, as a result, the original radial arrangement of the threads is no longer recognizable (l. c. fig. 21).

In the light of their own preparations as compared with Bonnevie's figs. 18–21, the writers are convinced that Bonnevie is describing the appearance of very poorly fixed and poorly stained nuclei. That Bonnevie has failed to distinguish between good and bad fixation is clear to the writers from the following (l. c. 198): "Ja, das Zusammenlaufen der Chromatinsubstanz kann soweit gehen, dass alles Chromatin des Kernes in einer einzigen, optisch schwer analysierbaren Masse zusammengeballt erscheint." This is true, but such phenomena do not represent normal steps in the mitotic process; they are largely artifacts. It is true, as has been pointed out some years ago by one of us (Mottier, '07, fig. 15), that chromatin granules may sometimes form accumulations either by themselves or grouped about the nucleolus, but such phenomena are to be regarded more on the order of chance occurrences than as representing significant and regularly appearing stages of the nucleus. It is conceivable that such accumulations of chromatin granules may be run together or fused by the reagents, and it is highly probable that the Chromatinknoten were formed in this manner. We do not find these masses of chromatin in our preparations. At any rate the Chromatinknoten of Bonnevie's figs. 18–21 are not to be regarded as of any consequence in the normal process of mitosis, as will be seen from what follows.

THE RESTING NUCLEUS AND SYNAPSIS

The nucleus of the resting stage in the pollen mother-cells of *Allium cernuum* Roth presents the well-known net or reticulum of linin upon which are distributed with more or less regularity the chromatin particles or granules. From one to several nucleoli of varying sizes are present. FIG. 1 illustrates the structure of

the nucleus in a pollen mother-cell soon after the last somatic division. The structure of the whole cell is the same as that of any somatic cell from any meristematic region. The growth period of both cell and nucleus now begins, and the very marked increase in the size of the nucleus as compared with that of the cell is very conspicuous in this as well as in other species of *Allium* (FIG. 2, 7, 8, 9). In FIG. 2 the nucleus is almost if not quite as large as it ever becomes. The nuclear reticulum is uniform, and the nucleoli may or may not be evenly spaced in the cavity of the nucleus. They do not lie in the same plane, and in making the drawing the focus was necessarily changed. FIG. 2 and all others represent rather thick sections of cells. Sometimes the chromatin granules form larger and smaller aggregates, which may be grouped about the nucleoli or removed from the latter, but we do not find large fused masses of chromatin such as Bonnevie has figured and described as "Chromatinknoten." A glance at FIG. 2 shows further that there may be a tendency to form a thread, that is, there will be seen stretches of linin in which the granules are arranged in lineal series. As pointed out by one of us (Mottier, '07) for *Lilium Martagon*, there is a tendency in *Allium cernuum* to form a delicate thread or spirem just before or as the nucleus passes into the synaptic contraction. FIG. 2 is about ready to begin the contraction of its net into the compact mass. FIG. 3 is a faithful attempt to illustrate the nuclear structure passing into synapsis, and FIG. 4 is a similar stage but includes the whole nucleus. These two figures were found in the same section of the loculus, in which were to be seen variously different stages of the early contraction. The writers wish to state most emphatically that there is no evidence of the fusion of two spirems during the contracting process. The spirem is formed directly from the nuclear network in the only way possible for a net to make a continuous thread, namely, by the breaking or dissolving of threads of certain meshes and the fusion of others. In the fusion of meshes several threads are seen to unite just as frequently and as certainly as one may find the fusion of only two threads. The appearance of the lateral union of two threads of certain meshes in several parts of the nucleus previous to synapsis is the strongest evidence, in the opinion of the writers, that those observers can bring forward

who hold to the doctrine that two spirems fuse side by side during, or prior to, synapsis and who deny that the somatic chromosomes are arranged end to end in a lineal series to make the continuous hollow spirem. These authors ignore the fact that three or more threads fuse in the formation of the spirem from the net as well as only two, and as will be pointed out in a subsequent paragraph, they omit from consideration and from their series of figures the most difficult and perhaps the most important steps in the formation of the bivalents from the hollow spirem.

FROM SYNAPSIS TO THE BIVALENTS

The stage of FIG. 4 passes directly into the closely contracted mass of FIG. 5. While the chromatin is still in this state, the thread gradually shortens and thickens into a heavy cord. Even before an appreciable loosening up of the synaptic ball it is readily seen that a thick spirem, or cord, is forming from the slender thread, and, as soon as the contracted mass loosens (FIG. 6), the correctness of this interpretation is beyond doubt. We have in our preparation transitional stages between FIG. 5 and 6, but it was not deemed necessary to include these in the series. The thick cord thus developed now becomes distributed throughout the nuclear cavity. In *Allium* it is relatively thick, apparently rather uniform in structure, though sometimes lumpy, and in many cases numerous delicate threads extend from the spirem to the nuclear membrane or between adjacent or parallel portions of the cord (FIG. 7, 8). A nucleolus is usually present. At this stage a longitudinal split may be sometimes seen, but this phenomenon is rather the exception than the rule (FIG. 8). This fission always closes up and the two halves become so closely applied or fused that the double nature of the thread, if really present, is completely concealed before any indication of cross segmentation is discernible.

Following the stage of the loose hollow spirem, the same undergoes a rearrangement before transverse segmentation, which results in a twisting, looping, and an entangling of its parts. This phenomenon found in the lilies and in other plants is known as the second contraction. In the lilies there is a central knotted or entangled portion of the spirem from which extend somewhat

radially loops and straight stretches of the cord, the latter with free ends. In *Allium cernuum* we do not find this typical appearance observed in *Lilium*. There is usually a tendency for the spirem to mass or become more closely entangled near the center of the nuclear cavity with a looping in the freer parts as shown in FIG. 10 and 11, which represent the less complicated condition, but, as a rule, the entanglement is so complicated that it is not possible to follow definitely more than a few loops or turns of the entire cord. If, for example, the spirem of FIG. 10 or 11 were bunched together more closely near the center with a greater twisting of the loops, we should have the more complicated state referred to above. The complexity of this step is increased by the fact that the spirem usually becomes more lumpy, or thicker places alternate with others more attenuated, just prior to, or as this rearrangement is ushered in (FIG. 9). Sometimes when the rearranged condition is not too confused, the spirem seems to be undergoing cross segmentation (FIG. 10), but whether this is the rule we are unable to say. It is certain, however, that in all, or in nearly all cases, the transverse segmentation of the spirem is accomplished during the entangled condition, or the stage of the second contraction. As segmentation is taking place there is always a violent twisting about each other of the two members of the bivalents, for as soon as the bivalents can be recognized as such, they invariably present the appearance of FIG. 12, save that they are more closely bunched together. Ordinarily they are heaped up in a more compact mass. For the illustration we have selected a nucleus in which a less entangled massing of the bivalents is present (FIG. 12).

That each bivalent, or the majority of them, represents a loop of the spirem, the two sides of which have twisted about each other, and not the two halves of the longitudinally split spirem, is in our opinion beyond question. The longitudinal split of the thread seen in the spirem disappears from sight, and, if it be present during the stages described, the two halves are so closely applied that no trace of the fission can be seen. Almost without exception the two members of each bivalent are twisted about each other, some tightly, others loosely (FIG. 12, 13). In all cases the bivalents, as soon as formed, are massed and entangled into a confused heap.

Later they separate and become irregularly distributed within the nuclear cavity (FIG. 14). At the same time they show a tendency to untwist, and as this is brought about the fact that many represent loops of the spirem is strikingly manifested.

Bonnevie figures the looped and twisted condition of the bivalents, but the manner in which they originate from the spirem is not satisfactorily shown. In fact Bonnevie does not seem to have taken cognizance of the stages which we have described as the rearrangement of the spirem, or the second contraction, and this author has not, in our opinion, shown how her FIG. 33 is derived from FIG. 30. In our opinion her figures not only disprove the very thing she attempts to demonstrate, but lend support to the view set forth in the foregoing paragraphs, namely, that the two members of each bivalent represent pieces of the spirem that were previously arranged end to end and not the longitudinal halves of parts of the spirem.

At the time of cross segmentation of the spirem the chromosomes have attained their largest size.* During the formation of the spindle and later they seem to undergo a condensation by which their size is much reduced. Their number is seven or eight. While seven only were counted in some cases, the writers are inclined to regard eight as the correct haploid number.

FROM SPINDLE TO DAUGHTER NUCLEI

As is so well known, the spindle develops first as a multipolar complex which gradually becomes bipolar. Within the complex of spindle fibers the chromosomes are usually crowded so that the transition from the tightly twisted state of the two members to the large open ring-shaped structure that appears rather constantly in the equatorial plate of the mature spindle, is not readily followed (FIG. 15–17). The ring-shape of the bivalents in the spindle is doubtless the most striking phenomenon in the whole mitotic process of *Allium cernuum*. This form of chromosome is brought about by the fact that the chromosomes are attached to the spindle fibers at a point about midway between the ends. As the two members of each bivalent thus attached are drawn apart by the

* The reader should bear in mind that FIG. 9, 10, 11, 12, 14, 18 and 19 are more highly magnified than FIG. 13, 15, 16, 17, etc.

spindle fibers, each is bent at the place of attachment and a ring results. In FIG. 16 some of the rings are seen from the edge while others have their flat sides turned toward the observer. In many of these rings it is still very evident that they were loops of the spirem as shown above. However, the open or closed ring is not the only form seen in the spindle stage. Sometimes the bivalents appear as two straight or crooked rods attached at or near the ends to the fibers, or **X**- and **Y**-shaped forms may appear.

One of the most conspicuous phenomena in the whole mitotic process of this species, and one which is very significant when viewed in the light of the kinetic processes involved in mitosis, is the shape of the chromosomes just before the appearance of the multipolar spindle and at the stage of the mature spindle (Fig. 13, 16, 17). In FIG. 13 the members of each bivalent, or at least the large majority of them, are tightly twisted about each other, while in FIG. 16 and 17 they appear just as uniformly as open rings. The question arises: what kinetic forces are responsible for the twisting in FIG. 13, and what for the condition of FIG. 17? A discussion of this interesting question would extend far beyond the limits of this paper, and we shall merely venture the opinion that neither magnetic nor osmotic activities seem applicable to the phenomena under consideration.

During metakinesis, that is, just at the instant when the segments are separated, each shows its longitudinal fission. Each half-ring, which is made into a **U** by the pull of the spindle fibers, is now a double **U**. Frequently just before metakinesis this longitudinal fission can be seen when the free ends of the bivalent are turned directly toward the observer (FIG. 18). In FIG. 19, an anaphase, the double **U**-like nature of the daughter segments is clearly shown. It may be remarked in passing that the large size and elongated form of the chromosomes of the mature spindle, and the fact that the halves of the **U**'s and **V**'s tend to separate from each other during the anaphase, make counting perplexing and uncertain, in spite of the large size and small number.

The shape and position of the various chromosomes as they pass to the poles seem to speak strongly in favor of a pull being exerted by the spindle fibers, which are in reality fine colloidal

threads and not expressions of osmotic currents. In fact it seems extremely difficult to bring any of these phenomena under explanations based upon osmotic activity.

On arriving at the poles, the chromosomes become closely crowded together in a manner well known for nearly all plants. In the organization of the daughter nuclei, the chromatin does not pass into the finely divided state by the processes of reticulation, alveolization or fragmentation as is characteristic of many gymnosperms and dicots. The various segments do elongate, however, to three or more times their original dimensions, becoming somewhat lumpy or irregular in outline, and finally form a sort of interrupted spirem which is seen as a series of longer or shorter loops or turns passing from the pole to the anti-pole side of the nucleus (FIG. 22). This figure represents a daughter nucleus seen somewhat obliquely from the polar side. The course of the spirem is usually more irregular than in this figure, there being many more short and abrupt genuflections or kinks. We have spoken of this spirem as discontinuous, for the reason that what are regarded as free ends can be found. These free ends are sometimes joined by very delicate threads like the anastomosing threads extending between parallel parts of the spirem in all cells whether purely vegetative or sporogenous. If the apparently free ends were connected by thicker threads, the spirem could then be spoken of as continuous. Whether or not this spirem is continuous or interrupted is of no theoretical importance. The side of each loop, or turn, is wavy or zigzag, due, of course, to the lack of space in the nuclear cavity for the placing of the greatly elongated segments. Whether continuous or interrupted, the whole forms a sort of crown or wreath open both at the pole and anti-pole sides. We assume that the adjacent or parallel sides of the loops are homologous with the sides of the U's or V's that pass to the poles during the previous anaphase. We do not find that the loops or ends of this spirem unite at the polar side to form "Chromatinknoten" either in these nuclei or in somatic cells that are normally preserved. A comparison of a daughter nucleus (FIG. 22) with a granddaughter nucleus (FIG. 23) shows that the arrangement of the chromatin is similar and that it is due to similar causes which may be and probably are purely mechanical.

SUMMARY

The resting nucleus prior to synapsis consists of a reticulum of linin and chromatin granules and of one or more nucleoli. The "Chromatinknoten" of Bonnevie are not present.

Before synapsis there is, as in *Lilium*, a tendency to form a delicate continuous thread or spirem. There is no union of two spirems in synapsis.

Synapsis is a real contraction of the nuclear net and not a growing away of the nuclear membrane from the nuclear network as claimed by Lawson.

The spirem is a direct transformation from the nuclear net.

The hollow spirem is a thick chromatin cord in which a longitudinal split is only occasionally seen and only in parts of the same. This split whenever present always closes up completely before the cross segmentation.

The rearrangement of the spirem takes place which is referable to the *second contraction* described for the lilies and other plants. This results in an entanglement of loops and parallel parts of the spirem which twist upon each other. During this rearrangement the transverse segmentation of the spirem occurs.

Each bivalent chromosome is formed by an approximation, usually side by side, of different lengths of the spirem, which may have appeared as loops or otherwise. Each bivalent is, therefore, to be regarded as two somatic chromosomes that were *previously arranged end to end in the spirem*. The approximation of two somatic chromosomes, side by side, or otherwise, or their adherence end to end to form bivalents, is not known as *synapsis* in botanical literature, nor is it properly called a conjugation.

The prevalent form of bivalent upon the mature spindle is the large ring, although other forms exist.

The daughter segments split longitudinally during metaphase. This fission may be looked upon as a preparation for the second, or homotypic, mitosis.

In the construction of the daughter nuclei, the chromatin does not pass into a finely divided state. The chromatin segments elongate greatly, becoming wavy or zigzag, and form an interrupted spirem by the union of a number of the free ends. This spirem is disposed in the form of a wreath or crown open at both

the polar and antipolar sides. The ends of the chromatin segments do not fuse into "Chromatinknoten" in the daughter nucleus.

INDIANA UNIVERSITY, BLOOMINGTON

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Explanation of plates 23 and 24

All figures were drawn from sections with the aid of the Abbé camera lucida and with Leitz 1/12 immersion and ocular IV or with Zeiss apochromatic immersion 2 mm., apert. 140, and compensating ocular 12. Magnification of figures 3, 4, 9, 10, 11, 12, 14, 18 and 19 about ×2000; all other figures about ×1600.

FIG. 1. Young pollen mother-cell soon after the last somatic division.

FIG. 2. Pollen mother-cell near the close of the period of growth. The nucleus is almost as large as it ever becomes.

FIG. 3. A thin section of a nucleus passing into synapsis; the net-work is forming a thread or spirem.

FIG. 4. A similar stage, showing nearly the whole nucleus. These two figures were near each other in the same section.

FIG. 5. Synapsis is complete.

FIG. 6. The synaptic mass loosening up. The very long, slender thread has shortened into a thick cord.

FIG. 7. The thick, hollow spirem.

FIG. 8. The same stage as FIG. 7. A longitudinal split is seen in two or three places.

FIG. 9. The spirem as it frequently appears before the rearrangement into the second contraction. At this stage the spirem may appear lumpy or with thicker and thinner portions.

FIG. 10, 11. Initial steps of the rearrangement. The chromatin cord is, as a rule, much more entangled than in these figures. Indications of transverse segmentation are seen in FIG. 10.

FIG. 12. Segmentation is about completed. The two members of each bivalent are twisted about each other.

FIG. 13. Similar to the preceding; the twisting is more pronounced in all chromosomes.

FIG. 14. Chromosomes beginning to untwist preparatory to the formation of the spindle.

FIG. 15. Multipolar stage of spindle.

FIG. 16, 17. The fully developed spindle. Nearly all of the chromosomes are rings.

FIG. 18. Spindle showing three chromosomes with the metaphase beginning. At the right a ring-shaped chromosome seen flatwise. In the center the two somewhat curved members of the bivalent are stretched out tangentially upon the spindle. The four free ends seen in these two chromosomes are indications of the longitudinal split. The chromosome at the left is a ring seen from the edge.

FIG. 19. An anaphase; the longitudinal fission of each daughter chromosome is very evident.

FIG. 20. A polar view of an anaphase. The halves of the longitudinally split daughter segments tend to separate.

FIG. 21. A typical anaphase in longitudinal section.

FIG. 22. A polar view of a daughter nucleus showing arrangement of the spirem into a system of loops.

FIG. 23. One cell of a tetrad, or granddaughter cell. The disposition of the chromatin is the same as in the daughter cells at the corresponding stage.

Contributions to the Mesozoic flora of the Atlantic coastal plain—IX. Alabama*

EDWARD W. BERRY

The Tuscaloosa formation as developed in western Alabama has been known for over fifty years to contain remains of fossil plants, and that it contained a large and varied Cretaceous flora has been known since Dr. Eugene A. Smith published a brief list of species in 1894. The principal items in the history of the study of this formation and its flora may be briefly enumerated as follows:

The Tuscaloosa formation was named by Smith and Johnson in 1887 (U. S. Geol. Surv. Bull. 43: 95) from the city and river (now usually known as the Warrior or Black Warrior River) of that name in Alabama. Earlier observers had noticed the presence of sands and clays below the recognized Cretaceous and above the Carboniferous, Professor L. Harper, the state geologist of Mississippi, mentioning them in print as early as 1856 (Proc. Acad. Nat. Sci. Phila. **8**: 126–128) and suggesting that their age is perhaps Permian or possibly Triassic. The same year Prof. Alex. Winchell mentioned the Tuscaloosa mottled clays, calling attention to the contained vegetable remains "appearing like the stems and leaves of dicotyledonous plants." He doubted their Triassic age and in his table of formations they appear in the Lower Cretaceous (Proc. Am. Asso. Adv. Sci. **10**[2]: 92. 1856). Meek and Hayden in discussing (Proc. Acad. Nat. Sci. Phila. **9**: 117–133. 1857) the Alabama Mesozoic mentioned wood and leaves and correlated the lower part with the lowest Cretaceous of New Jersey and Nebraska. Their lithologic characterization clearly indicates that they are discussing the Tuscaloosa, and they say that although the weight of the evidence favors the correlating

* Published by permission of the Director of the United States Geological Survey. The present paper is a brief abstract of the systematic chapter of a Monograph of the Upper Cretaceous floras of the eastern Gulf Coastal Plain, submitted for publication by the U. S. Geological Survey, this study being a part of the Coastal Plain Investigations directed by T. Wayland Vaughan.

of these beds with the Neocomian of the Old World positive evidence is lacking that a part may not be older than Cretaceous. Subsequently, Professor Hilgard (Geol. and Agr. Miss. 61. 1860) described the beds in Mississippi beneath his Tombigbee sands as the Eutaw group and referred them to the Cretaceous. The following year Meek and Hayden restated their views and definitely correlated the beds in Alabama with the Dakota of the Western Interior (Proc. Acad. Nat. Sci. Phila. 13: 419–421. 1861).

Again in 1876 Meek (U. S. Geol. Surv. Terr. 9: 38–42) reaffirms his belief that the basal Cretaceous of Alabama is of the same age as the plastic clays of New Jersey and the Dakota sandstone of the Upper Missouri section.

All of these geologists failed to discriminate the Tuscaloosa from the overlying sands and laminated clays of what is now known as the Eutaw formation. The first reasonably complete account of the Tuscaloosa formation is given by Smith and Johnson in the publication previously alluded to. From the attitude, lithologic character, and stratigraphic position of the beds they correlated the Tuscaloosa with the Potomac of the Middle Atlantic slope, which had just been named and briefly described by McGee (Rep. Health Officer Dist. of Columbia for the year ending June 30, 1885: 19–21, 23–35), a natural correlation since the Potomac as understood in the earlier days of its study included beds which according to the opinions of different students were referred to various levels ranging from the Triassic to the Cretaceous and which subsequent study has shown to constitute a series of well-marked formations, the oldest of Neocomian age and the youngest of Cenomanian age.

From the year 1883 down to the present Dr. Eugene A. Smith, the distinguished state geologist of Alabama, has added to our knowledge of these deposits, being assisted in the earlier years by L. C. Johnson and D. W. Langdon, Jr. The discovery of all of the noteworthy localities for fossil plants is due to their efforts. In 1884 some leaf impressions collected by Langdon in Bibb County were submitted to Leo Lesquereux, among which he recognized a species of *Podozamites* which he thought might indicate a pre-Cretaceous age. Lesquereux afterward determined

a small collection of leaves from the Tuscaloosa beds at Tuscaloosa but this list seems never to have been published.

In 1886 Smith and Langdon discovered several localities for fossil plants in the vicinity of Tuscaloosa (Cottondale, Snows Place, Tuscaloosa) and the next year the United States Geological Survey sent Professor Fontaine into the field.

The latter made large collections of mostly fragmentary material from these outcrops as well as from one or two other outcrops near the town of Tuscaloosa. In 1892 Professor Lester F. Ward visited Alabama and in company with Dr. Smith made extensive collections from Glen Allen and Shirleys Mill. These collections received a preliminary study by Professor Ward, who furnished a list of 35 species which was published by Smith in 1894 in his Report on the Geology of the Coastal Plain of Alabama. This list enumerated the following forms:

Andromeda latifolia Newb. = *Andromeda grandifolia* Berry
Andromeda novae-calcareae Hollick (*Novae-Caesareae*)
Andromeda Parlatorii Heer
Aralia Wellingtoniana Lesq. = *Aralia cottondalensis* Berry
Carpolithus floribundus Newb.
Celastrophyllum crenatum Heer
Celastrophyllum undulatum Newb.
Cinnamomum intermedium Newb. = *Cinnamomum Newberryi* Berry
Cladophlebis parva Font. = *Cladophlebis alabamensis* Berry
Cycadinocarpus circularis Newb.
Czekanowskia capillaris Newb.*
Dewalquea groenlandica Heer*
Diospyros primaeva Heer
Eucalyptus attenuata Newb.*
Eucalyptus nervosa Newb.*
Eucalyptus parvifolia Newb.*
Ficus inaequalis Lesq.
Ficus lanceolato-acuminata Newb.*
Ficus Woolsoni Newb.
Liriodendropsis angustifolia Newb.
Liriodendropsis simplex Newb.
Magnolia alternans Heer*
Magnolia auriculata Newb.
Magnolia glaucoides Newb. = *Magnolia Boulayana* Lesq.
Magnolia longifolia Newb. = *Magnolia Newberryi* Berry
Magnolia speciosa Heer
Myrsine borealis Heer
Populus apiculata Newb. = *Cordia apiculata* Berry
Proteoides daphnogenoides Heer = *Ficus daphnogenoides* Berry
Pterospermites modestus Lesq.*
Tricalycites papyraceus Newb.
Widdringtoniles Reichii (Ett.) Heer
Sequoia gracillima (Lesq.) Newb. = *Widdringtoniles Reichii* (Ettings.) Heer
Sequoia heterophylla Velenovsky
Sequoia Reichenbachi (Gein.) Heer

In preparation for my work I spent the field season of 1909 in Alabama, revisiting all of the known plant localities and making extensive collections. In company with Dr. L. W. Stephenson the Warrior and Tombigbee river sections were studied by means

* Not recognized by me.

of a launch trip from Tuscaloosa down to the Eocene contact at Moscow; the Coosa and Alabama rivers were traversed from Wetumpka to Montgomery; the Chattahoochee River from Columbus to Gainesville; the upper Tombigbee River in Mississippi and various localities in Tishomingo, Prentiss, and Itawamba counties, Mississippi, were explored. I have also had the benefit of the collections and notes made by Dr. L. W. Stephenson in his extensive field and office studies on the stratigraphy and paleozoology of the Cretaceous of the Eastern Gulf area, as well as the extensive collections previously made for the United States Geological Survey by Smith, Fontaine, and Ward. All of the types and duplicate material are in the collections of the United States National Museum.

Recognizable fossil plants have been found at the following localities in Alabama and a single locality in northeastern Mississippi: near Iuka, Mississippi; Glen Allen, Shirleys Mill, Tuscaloosa, Cottondale, Snow Place, Sanders Ferry Bluff, Whites Bluff, and several other localities in Alabama where only one or two species have been found. The identifiable species other than those new to science are enumerated in the following notes.

LOCALITY NEAR IUKA, MISSISSIPPI

This is the most northerly known plant-bearing outcrop of the Tuscaloosa formation. It is situated in a cut on the Southern Railway $1\frac{5}{8}$ miles east of Iuka in Tishomingo County, and while near the base of the formation in this county it is younger than the plant-bearing Tuscaloosa localities in Alabama.

The following species associated with water worn pellets of amber occur at this outcrop: *Andromeda Wardiana* Lesq., *Androvettia carolinensis* Berry, *Sequoia Reichenbachi* (Gein.) Heer.

LOCALITY NEAR GLEN ALLEN, ALABAMA

This outcrop is in a cut of the St. Louis and San Francisco R. R. about one-quarter of a mile east of Glen Allen near the northern boundary of Fayette County. The following species occur here:

Andromeda grandifolia Berry
Andromeda Novae-Caesareae Hollick
Andromeda Parlatorii Heer
Bauhinia marylandica Berry
Cinnamomum Newberryi Berry
Cissites formosus Heer

Cornophyllum vetustum Newb.
Cycadinocarpus circularis Newb.
Diospyros primaeva Heer
Diospyros rotundifolia Lesq.
Ficus daphnogenoides (Heer) Berry
Ficus Krausiana Heer
Ficus Woolsoni Newb.
Ilex Masoni Lesq.
Liriodendropsis simplex Newb.
Lycopodium cretaceum Berry
Magnolia Lacoeana Lesq.
Magnolia Newberryi Berry
Magnolia speciosa Heer
Marattia cretacea Velenovsky (?)
Myrsine borealis Heer
Myrsine Gaudini (Lesq.) Berry
Pterospermites carolinensis Berry
Salix Lesquereuxii Berry
Tricalycites papyraceus Newb.
Widdringtonites Reichii (Ettings.) Heer
Zizyphus lamarensis Berry

LOCALITY AT SHIRLEYS MILL, ALABAMA

This outcrop is about twenty-five miles south of Glen Allen in southern Fayette County at a point where the old Fayette-Tuscaloosa coach road descends to the Davis Creek bottom. The following species occur at this locality:

Acerates amboyensis Berry
Andromeda grandifolia Berry
Andromeda Novae-Caesareae Hollick
Andromeda Parlatorii Heer
Andromeda Wardiana Lesq.
Asplenium Dicksonianum Heer
Bauhinia cretacea Newb.
Bauhinia marylandica Berry
Brachyphyllum macrocarpum formosum Berry
Carpolithus floribundus Newb.
Celastrophyllum Brittonianum Hollick
Celastrophyllum decurrens Lesq.
Celastrophyllum grandifolium Newb.
Celastrophyllum Newberryanum Hollick
Cinnamomum Newberryi Berry
Citrophyllum aligerum (Lesq.) Berry
Colutea obovata Berry
Crotonophyllum panduraeformis Berry
Dammara borealis Heer
Dermatophyllites acutus Heer
Dewalquea Smithi Berry
Dicksonia groenlandica Heer
Diospyros amboyensis Berry
Diospyros primaeva Heer
Diospyros rotundifolia Lesq.
Ficus daphnogenoides (Heer) Berry
Ficus inaequalis Lesq.
Ficus Krausiana Heer
Ficus Woolsoni Newb.
Geinitzia formosa Heer
Gleichenia delicatula Heer
Inga cretacea Lesq.
Juglans arctica Heer
Kalmia Brittoniana Hollick
Laurophyllum nervillosum Hollick
Laurus plutonia Heer
Leguminosites omphaloboides Lesq.
Liriodendropsis angustifolia Newb.
Liriodendropsis constricta Ward
Liriodendropsis simplex Newb.
Lycopodium cretaceum Berry
Magnolia Boulayana Lesq.
Magnolia Hollicki Berry
Magnolia Lacoeana Lesq.
Magnolia longipes Newb.
Magnolia obtusata Heer
Magnolia speciosa Heer
Malapoenna falcifolia (Lesq.) Knowlton
Myrica emarginata Heer
Myrsine borealis Heer
Nyssa Snowiana Lesq.
Palaeocassia laurinea Lesq.
Panax cretacea Heer
Persoonia Lesquereuxii Knowlton
Phaseolites formus Lesq.
Protodammara speciosa Hollick & Jeffrey
Pterospermites carolinensis Berry
Rhamnus tenax Lesq.
Salix flexuosa Newb.
Salix Lesquereuxii Berry
Salix Meekii Newb.
Sequoia heterophylla Velenovsky
Tricalycites papyraceus Newb.
Widdringtonites Reichii (Ettings.) Heer
Widdringtonites subtilis Heer

LOCALITIES NEAR TUSCALOOSA

The following list embraces species occurring at several outcrops in and near the town of Tuscaloosa in Tuscaloosa County:

Andromeda grandifolia Berry
Andromeda Parlatorii Heer
Diospyros primaeva Heer
Ficus daphnogenoides (Heer) Berry
Ficus Woolsoni Newb.
Magnolia speciosa Heer
Salix flexuosa Newb.
Salix Lesquereuxii Berry

LOCALITY NEAR COTTONDALE

This locality is along the public road about 10 miles east of Tuscaloosa and two miles southeast of the town of Cottondale in Tuscaloosa County. The following species have been identified from this outcrop:

Andromeda Parlatorii Heer
Bauhinia cretacea Newb.
Bauhinia marylandica Berry
Celastrophyllum crenatum Heer
Celastrophyllum grandifolium Newb.
Celastrophyllum undulatum Newb.
Cinnamomum Newberryi Berry
Citrophyllum aligerum (Lesq.) Berry
Cocculus cinnamomeus Velenovsky (?)
Diospyros primaeva Heer
Ficus daphnogenoides (Heer) Berry
Ficus inaequalis Lesq.
Ficus Krausiana Heer
Ficus Woolsoni Newb.
Geinitzia formosa Heer
Ilex Masoni Lesq.
Juglans arctica Heer
Laurus plutonia Heer
Liriodendron Meekii Heer
Magnolia Capellinii Heer
Magnolia longipes Newb.
Magnolia speciosa Heer
Malapoenna cretacea (Lesq.) Knowlton
Myrica emarginata Heer
Myrsine Gaudini (Lesq.) Berry
Persea valida Hollick
Phaseolites formus Lesq.
Pinus raritanensis Berry
Platanus latior (Lesq.) Knowlton
Populus hyperborea Heer
Protophyllocladus subintegrifolius (Lesq.) Berry
Pterospermites carolinensis Berry
Salix Lesquereuxii Berry
Sassafras acutilobum Lesq.
Sequoia Reichenbachi (Gein.) Heer

LOCALITY ON SNOW PLANTATION

Two plant-bearing outcrops occur on the Snow Plantation about nine miles southwest of Tuscaloosa. These are known in the literature as "Upper Ravine" and "Big Gully, Snow Place" and are in enormous gullies eroded into the upland from the west bank of the Warrior River. The following species occur here:

Abietites foliosus (Font.) Berry
Andromeda grandifolia Berry
Andromeda Novae-Caesareae Hollick
Andromeda Parlatorii Heer
Celastrophyllum carolinense Berry
Celastrophyllum crenatum Heer
Dammara borealis Heer
Dicksonia groenlandica Heer
Dryopterites Stephensoni Berry
Eucalyptus Geinitzi Heer
Eucalyptus latifolia Hollick
Ficus crassipes Heer

Ficus daphnogenoides (Heer) Berry
Ficus Krausiana Heer
Laurophyllum angustifolium Newb. (?)
Myrica emarginata Heer
Myrsine borealis Heer
Podozamites marginatus Heer
Salix flexuosa Newb.
Salix Lesquereuxii Berry
Sequoia ambigua Heer
Sequoia fastigiata (Sternb.) Heer
Sequoia Reichenbachi (Gein.) Heer
Tricalycites papyraceus Newb.
Widdringtonites Reichii (Ettings.) Heer
Widdringtonites subtilis Heer

SANDERS FERRY BLUFF

This locality is on the west bank of the Warrior River about eleven miles southwest of Tuscaloosa in the county of that name. The following plants occur at this outcrop:

Acerates amboyensis Berry
Ficus crassipes Heer
Ficus Krausiana Heer
Salix flexuosa Newb.
Salix Lesquereuxii Berry

WHITES BLUFF OUTCROP

This locality is on the right bank of the Warrior River in northeastern Green County, three hundred and nine miles above Mobile and near the top of the Tuscaloosa formation. The following species have been identified from this outcrop:

Brachyphyllum macrocarpum formosum Berry
Dewalquea Smithi Berry
Sequoia heterophylla Velenovsky
Sequoia Reichenbachi (Gein.) Heer
Widdringtonites Reichii (Ettings.) Heer

In addition to the well-known Cretaceous species in the foregoing lists the Tuscaloosa formation has yielded upwards of fifty new species which are described in the following genera: *Aralia*, *Calycites*, *Capparites* (2), *Carpolithus*, *Cassia*, *Celastrophyllum* (5), *Cladophlebis*, *Cocculus* (2), *Conocarpites*, *Eorhamnidium*, *Equisetum*, *Eugenia*, *Ficus* (3), *Grewiopsis* (2), *Hymenaea*, *Jungermannites*, *Leguminosites* (3), *Lycopodites*, *Malapoenna*, *Menispermites* (2), *Myrica*, *Oreodaphne*, *Persoonia*, *Phyllites* (2), *Piperites*, *Platanus* (2), *Populites*, *Proteoides*, *Sapindus*, *Sapotacites* (3), and *Sphaerites*.

The flora as a whole comprises over 150 species, of which over 40 per cent. of the genera are not represented in the existing flora. None of the species survive into the lower Eocene.

Eighty-seven genera segregated into 48 families in 31 orders are represented, the most abundant orders being the Ranales with 15 species, the Coniferales with 14 and the Urticales with 8. The largest single genus is *Celastrophyllum* with 12 species. The

Dicotyledonae of the Tuscaloosa formation number 123 species, distributed in 34 families in 21 orders. The Choripetalae number 107, the Gamopetalae but 16 forms.

The flora as a whole is a lowland coastal flora, many of the species being strand types. It indicates a land surface of rather uniform topography, an abundant and well-distributed rainfall, equable temperatures of warm temperate or subtropical type, with slight seasonal changes.

Meager floras are found also in the younger Cretaceous strata of the Eutaw and Ripley formations, but these are not included in the present contribution.

JOHNS HOPKINS UNIVERSITY,
BALTIMORE.

A bibliography of works on meiosis and somatic mitosis in the Angiosperms

MAURICE PICARD

The accompanying bibliography was prepared, in the first instance, for the compiler's personal use. He publishes it, believing that there is need of such a means of reference to the works on meiosis and somatic mitosis in the plants already studied, and that, by such publication, interest may be aroused in the groups hitherto neglected. As far as the writer knows, there is no such bibliography in existence at the present time, nor has the plan of citing literature on mitosis with reference to the systematic position of the plants studied ever been adopted. Inasmuch as the object of the bibliography is to provide a working basis for further research no attempt has been made to make the citations on the individual plants exhaustive. It is believed, however, that from the citations given one can obtain references to all the literature. Works published before 1880 have not been cited; the citations extend to May, 1913. Works on the morphological development of the male and female gametophytes have been mentioned only when they contain matter of cytological interest. The writer has used his own discretion with respect to articles of questionable relevance, and also in deciding whether or not incidental references to somatic mitosis should be cited.

The bibliography was compiled chiefly at the libraries of Cornell University, Columbia University, and the New York Botanical Garden; and my thanks are due to their librarians for courtesies shown me. I am also obliged to Professor G. F. Atkinson, Professor R. A. Harper, and Dr. A. B. Stout for access to some otherwise unobtainable articles, and to Professor G. F. Atkinson for examining the manuscript sheets.

The writer is aware that such a bibliography as here presented must be inadequate in many ways, and he hopes that those who can will acquaint him with omitted references.

The nomenclature employed is that of N. L. Britton's "Manual

of the Flora of the Northern States and Canada," 2d ed., 1907, when the plants cited are contained in this volume. In the case of forms not within the range of this work, the nomenclature follows the rules laid down by the International Botanical Congress at Vienna. Where the two systems differ, the designation of the Vienna code is added in parentheses.

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CORNELL UNIVERSITY, ITHACA.

INDEX TO AMERICAN BOTANICAL LITERATURE
(1910–1913)

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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